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The Control of Garden Insects and Diseases

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and

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Injury from Squash Vine Borer

A Profitable Garden for Both Suburban and Rural Home

This bulletin contains valuable information on insects and diseases of vegetables, small fruits, and some common flowers.

It will help to prevent wasted labor in your garden.

Its aim is to be specific and brief.

Its recommendations apply especially to the small garden, but most of them can be used profitably by the commercial vegetable grower) see page 61).

It contains the best known control measures.

Only a few of the insects or diseases mentioned may become troublesome in any one season, but all are common in Ohio.

Read the descriptions of the principal pests of the crops you are growing.

Proper use of materials is discussed in detail on pages 49 to 64.

Be accurate in weighing and measuring ingredients.

Select good disease-free stock; treat seed before planting (see page 62).

Purchase recommended disease-resistant varieties, if possible.

Spray or dust for insects *before* damage is done, but not unless you know it is necessary.

Remedies for plant diseases are primarily preventive. They should be applied *before* disease appears. Application made as soon afterwards as possible may reduce the loss.

Do not apply sprays leaving poisonous residues on fruits or vegetables soon to be eaten.

Cultural practices should be followed as an aid in controlling insects and diseases.

Should you fail to identify your trouble call your County Agent. If necessary, he can secure the services of specialists from the College of Agriculture. Such service is free.

Keep this bulletin handy and check with your county agent about new editions.

THE OHIO STATE UNIVERSITY AND THE U. S. DEPARTMENT OF AGRICULTURE, COOPERATING AGRICULTURAL EXTENSION SERVICE—C. M. FERGUSON, *Director*, Columbus, Ohio
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The Control of Garden Insects and Diseases

By T. H. PARKS, Extension Entomologist, Ohio State University, and
J. D. WILSON, Associate Plant Pathologist, Ohio Experiment Station

INTRODUCTORY

MANY of the fresh vegetables and small fruits consumed on the farm are grown in home gardens or small truck patches which are kept to supply the needs of the farm home. The subsistence and community gardens in cities and villages furnish a profitable source of supply of fresh vegetables for these homes. Many of these gardens are cared for by persons who have had little experience in growing vegetables. Both the home and commercial gardens suffer heavy losses from the ravages of insect pests and plant diseases. Much of this loss can be prevented by timely remedies at a very nominal cost to the owner. It is for the purpose of preventing much of this waste that this bulletin has been prepared.

The authors have drawn on their personal experiences, as well as the experiences of many growers and have reviewed many publications. They have then chosen the most reliable recommendations based on control work for each insect or disease. As far as possible, necessary weighing of small amounts has been done and the equivalent expressed in measurements of pints, half-pints, or level tablespoons. So-called "standard formulas" have been omitted, as it is known that insecticides and fungicides vary in their effectiveness and their safety on foliage.

Some plant diseases, and some underground insects cannot be controlled entirely. Where this is the case it has been so stated and methods of partial control suggested. Many minor crop troubles have not been included. Some well-selected pictures have been included to aid in identification.

HOW TO USE THIS BULLETIN

The arrangement followed is in the form of a "calendar" which lists the garden crops in alphabetical order, together with the insects and diseases most likely to attack them. Names of plant diseases are in *italics*. To use this "calendar," find the name of your crop in its alphabetical order; read the description of the insects or diseases of this crop, and from this identify your trouble; then prepare and apply the spray or other controls recommended for this insect or disease. For a discussion of materials recommended see pages 51 to 64.

The spray and dust formulas recommended for the control of the various diseases and insects may be identified as follows:

Spray formulas are indicated when the *last* number given is 100 (as 4-6-100).

Dust formulas are indicated when the *last* number given is less than 100 (as 14-86).

The preferred treatment is mentioned first.

Apply most sprays at 150-175 gallons per acre, and most dusts at 40 to 50 pounds per acre.

ALL OR MOST GARDEN PLANTS

Insect or Disease	Description	Remedy or Prevention
WHITE GRUBS (Fig. 1)	Large white larvae with hard brown heads. Live under the surface of soil	No remedy, except prevention If grubs are discovered in the seedbed, sow more seeds and thin out later For grubs in lawns see Grass (page 27) For grubs in strawberry beds (page 43)
WIREWORMS (Fig. 2)	Long, slender, yellow or brown larvae living in the soil	Avoid planting potatoes, sweet corn or strawberries in soil known to be infested. Where soil is discovered to be infested at time of preparation, cultivate to prevent weed growth and select a crop that can be planted late like beans or turnips
CUTWORMS (Fig. 12)	Need no description	Use poisoned bran mash before plants come up or are transplanted (see page 60)
GRASSHOPPERS (Fig. 25)	Need no description	Use poisoned bran mash (see page 60), *or* spray or dust with chlordane (see page 59) when grasshoppers first appear
MOLES	Need no description	See Grass (page 27)
SLUGS	Small, slimy, snail-like creatures which live under leaves and in loose soil during day and feed at night	Remove trash, leaves, and other protection from border of garden Scatter lime over soil on beds to be protected Apply a metaldehyde bait sold commercially
Damping-off	Seedlings die before emergence or rot off later at surface of ground	Treat seed and sterilize soil before planting (pages 62-64) Plant seeds thinly in rows Keep surface of soil stirred after seeds come up. Water thoroughly at long intervals Allow as much sunlight and air to reach the plants as possible

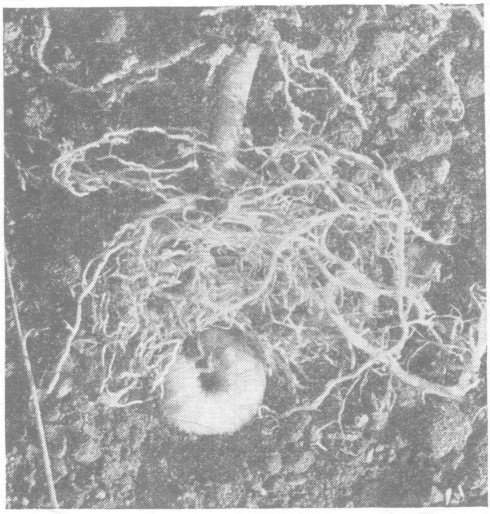


Fig. 1.—White grub feeding underground

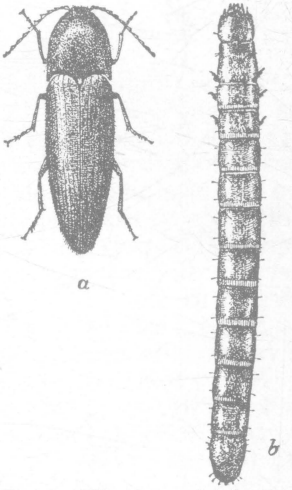


Fig. 2.—Wireworm; (*a*) beetle, (*b*) *larva.*

ASPARAGUS

Insect or Disease	Description	Remedy or Prevention
ASPARAGUS BEETLE (Fig. 3)	Small beetles about ¼" long, red thorax and blue wing covers marked with red and yellow Larvae are soft olive-colored grubs that feed on shoots and foliage	Cut off young shoots closely every 4 days during cutting season. Leave some shoots uncut for attracting beetles, then either spray these shoots with rotenone carrying a sticker, or dust with 0.75% rotenone (see page 51); *or* Spray or dust with DDT (see page 52)
Rust	Tops of plants turn yellow and die early Elongated reddish-brown or black pustules on stems and leaves	Grow a rust-resistant variety such as Mary Washington, Martha Washington

Fig. 3.—Asparagus beetle.

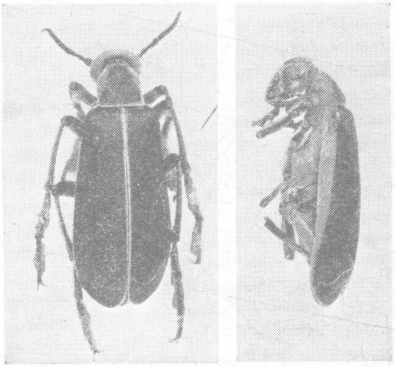


Fig. 4—Blister beetles.

ASTER

LEAF BEETLE (12-spotted) (Fig. 26)	Yellowish-green beetles, ½" long, with twelve prominent black spots on wings. Eat holes in leaves	Spray or dust with DDT (see page 52)
BLISTER BEETLE (Fig. 4)	Black or gray elongate beetles ½ to ⅝ inch in length which frequently appear in large numbers and ruin the flowers and buds	Spray or dust plants with fluorine compound (see page 59); *or* Spray or dust with DDT (see page 52)
ROOT APHIS	Bluish-green plant lice attack the roots, causing growth to stop and leaves turn yellow	Destroy ants which foster these aphids (see page 26) Work into the soil about the roots fresh tobacco dust when insects are found; *or* Loosen soil about portion of roots and pour into it nicotine sulfate solution at strength of 1½ teaspoons to 1 gallon of water
LEAFHOPPER (Fig. 41)	Small yellowish-green insects that suck sap from under-surface of leaves. Winged ones fly away upon disturbance Insects transmit "yellows" disease	Spray or dust under-surfaces of leaves lightly with DDT (see page 52)

ASTER (Continued)

Insect or Disease	Description	Remedy or Prevention
Fusarium wilt	Seedlings may wither quickly and die. Dark streak up one side of stem on older plants, followed by death of entire plant. Base of stem dark with a brown vascular ring just beneath the "bark"	Disinfect commercial seed and sow in sterilized soil Grow wilt resistant varieties (see seed catalogs) Grow plants in new location each year
Yellows (virus)	New growth yellowish, plants dwarfed, with rosetted appearance. Upper leaves erect. Flower heads open unevenly or only partially and have greenish cast	Pull up and burn diseased plants when noticed. Keep weeds down Grow plants under insect proof cheesecloth cages. Aster cloth must have 22 by 22 threads per square inch
Rust	Orange-colored powdery pustules on lower side of leaves	Dust with 325-mesh sulfur dust, or with sulfur-Fermate (90-10) once a week beginning about July 1st until flowers start to change color

BEAN

Fig. 5.—Field of snap beans seriously injured by Mexican bean beetle (see page 7).

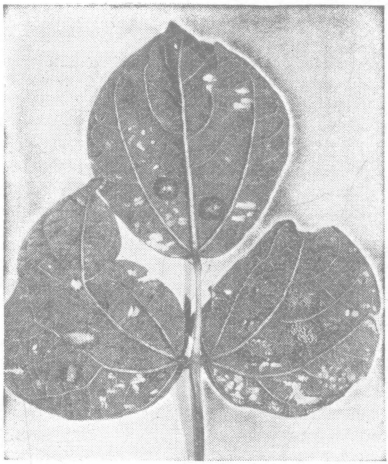


Fig. 6.—Mexican bean beetle.

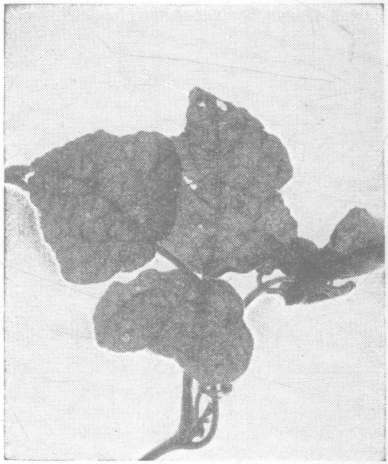


Fig. 7.—Bean plant stunted by leafhoppers.

Insect or Disease	Description	Remedy or Prevention
LEAFHOPPFR (Fig. 7)	Small, green, active insects on underside of leaves. Adults fly; young walk sidewise Leaves become distorted and plants stunted	Dust undersides of leaves lightly with 3% DDT. Repeat at weekly intervals Combine the DDT dust with rotenone if Mexican bean beetle is present
BEAN LEAF BEETLE (Fig. 9)	Yellowish to reddish beetle about ⅓" long. Black band extends round edge of wing-cover. Two rows of 3 black spots extend along inner margin. Legs marked with black and yellow. Beetles eat holes in leaves Larvae feed on roots and underground stem	Same treatment as for Mexican bean beetle; *or* Spray or dust upper surface of leaves with DDT which controls this beetle, but not the Mexican bean beetle (see page 52) No control for larvae
MEXICAN BEAN BEETLE (Figs. 5, 6)	Copper colored hemispherical beetles about ¼ inch long with 8 black spots on each wing cover Larvae are yellow and covered with dark spines	Rotenone is the most efficient insecticide As soon as eggs, or young larvae appear, spray undersides of leaves with rotenone extract, or with 4 level tablespoons of ground derris or cube root in 1 gal. water, 1 pint to 8 gals. (see page 51); *or* Dust undersides of leaves with rotenone pwd. 0.75 per cent rotenone. Purchase and apply a dust carrying both rotenone and DDT if leafhoppers are also present (see pages 52-53); *or* Spray or dust lightly with fluorine compound (see page 59)

BEAN (Continued)

Insect or Disease	Description	Remedy or Prevention
RED SPIDER (Fig. 34)	Very minute mites on the leaves causing them to appear speckled, and plants dwarfed	Spray both sides of leaves with one of the wettable sulfurs or flotation sulfur as soon as red spiders are noticed. Repeat in 7 to 10 days; *or* Dust with finely ground sulfur dust
APHIS	Small, black lice which cluster on stalks and underside of leaves	Dust insects with nicotine dust (see page 54); *or* Spray insects with nicotine sulfate, 2 teaspoons to 1 gal. soapy water (page 54)
SEED MAGGOT	White maggots that attack cotyledons before beans come up. Cotyledons later have rusty tunnels	No remedy except prevention Plant seed shallow if soil is cold. Later planted seed is usually undamaged
WEEVIL	Beetles which develop in the dry seeds	Harvest beans soon after they mature Store beans with ¼ their volume of hydrated lime well shaken throughout beans; *or* Fumigate *infested* seed with carbon bisulfide, *or*, Use dry heat method (see p. 61) For small quantity, suspend the *infested* seeds in a kettle of cold water and heat the water to 140° F. Dry seed quickly
Bacterial blight (Fig. 8)	On leaves, irregular watery light-green patches becoming wilted, then dry, brown and brittle with a yellow border On pods, small watery spots enlarging to irregular blotches, later becoming dry and sunken, brick-red to brownish color	Select seed from healthy plants or buy seed certified to be free from bacterial blight Do not work with wet plants For *dry beans*, use tolerant varieties as Michigan Robust Pea, Yellow Eye, Michelite, or Great Northern For *snap beans*, try Refugee 1000-1, Refugee Wax, Late Stringless Green Refugee, Tendergreen, Asgrow Stringless, or Improved Kidney Wax
Rust	Small rust-colored or brown pustules on leaves and sometimes on pods	Burn diseased plants after harvest. Grow resistant varieties like Wisconsin Refugee. Dust with sulfur 20-25 lbs. per acre early in season. If 2 applications are necessary 15 lbs. 1st and 20 lbs. sulfur in 2nd.

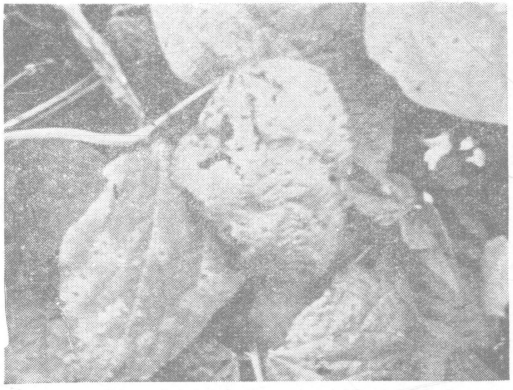


Fig. 8.—Bacterial blight on snap beans (black spots in halos; leaf at left shows early stages; leaves become ragged in later stages).

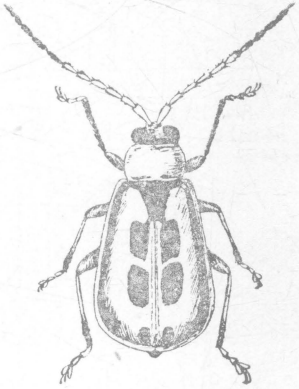


Fig. 9.—The bean leaf beetle. (From Cornell Agr. Exp. Sta.)

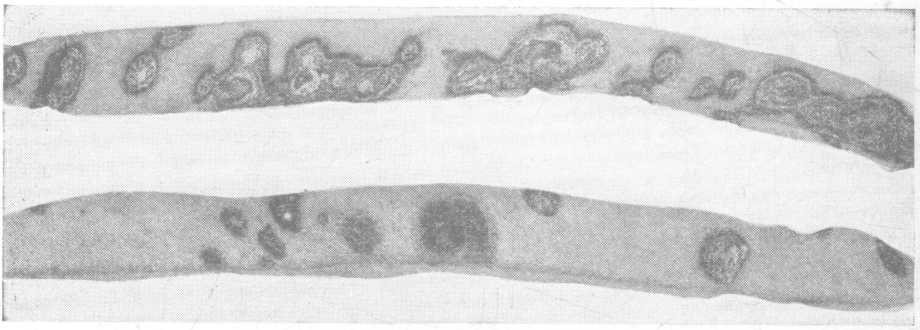


Fig. 10.—Anthracnose on beans.

BEAN (Continued)

Insect or Disease	Description	Remedy or Prevention
Anthracnose (Fig. 10)	On pods, tiny brown specks which later enlarge, turn black at center with light brown to purplish-brown border; mature spots, circular to oval with borders sunken, gray center marked by tiny black specks. Lesions on leaves small, angular; infected portion of lower veins turns black. Attacks all parts of plant above ground	Rotate crops and plow down old bean tops as soon as harvested Select seed from healthy plants and pods, or buy western grown seed Do not work with wet plants *For dry beans*, use tolerant varieties as Michigan Robust Pea, Perry Marrow, Yellow Eye, Scotia, or Genesee Pea *For snap beans*, try Livingston's Pencil Pod Wax, Keeney's Rustless Golden Wax, Longfellow, Black Valentine, or Hopkins' Earliest Red Valentine
Mosaic	Leaves have irregular light areas merging with darker green, often raised patches producing mottling	Get clean seed from a reliable seed house *For dry beans*, grow resistant varieties like Michigan Robust Pea, White Marrow, Red Marrow, Michelite *For snap beens*, use Idaho Refugee, Wisconsin Refugee, Corbett Refugee, or Refugee U. S. No. 5
Downy mildew (on Limas)	White downy mold on pods which later shrivel, die, and turn black. Tender growth may be infected and distorted	Rotate crops Use well drained soil Spray at weekly intervals with Parzate, or Dithane Z-78 with 2-100 formula; *or* dust with a 6-94 formula. Start just before bloom if disease is present in garden or neighborhood and continue with at least 3 applications after bloom

BEET

FLEA BEETLE (Fig. 37)	Tiny black or striped beetles which eat small holes in leaf. Have jumping habit	Spray or dust the plants with rotenone (see page 51), *or* with DDT (see page 52), *or* with fluorine compound (see page 59)
LEAF-MINER (Fig. 54)	Sections of the leaf turn brown, due to a yellowish-white maggot devouring the green tissues between the upper and lower epidermis	Destroy the wild host, which is lamb's-quarters

BEET (Continued)

Insect or Disease	Description	Remedy or Prevention
Cercospora leaf spot	Circular brown or gray spots with red borders on leaves	Use crop rotation If serious, use fixed copper spray, or dust as for Tomato; or use bordeaux mixture 8-8-100 when spots appear and at 10-day intervals (see page 55)

CABBAGE AND CAULIFLOWER

IMPORTED CABBAGE WORM (Fig. 11)	Soft-bodied velvety green worms	Dust plants lightly with DDT (see page 52) Do *not* apply DDT after head is well formed *or* Dust plants when worms first appear with rotenone dust as recommended on page 51. Rotenone is safe any time
CABBAGE LOOPER	Pale green looping caterpillar with longitudinal stripes	
DIAMOND-BACK MOTH LARVAE	Very small pale green worms which eat into leaf from beneath but do not cut holes through to upper surface	Sprays are not as effective as dusts unless a sticker is added as recommended for nicotine sulfate
APHIS	Small, gray lice which collect in areas on the leaves and cause yellow spots and curling	Dust lice well with nicotine dust (see page 54); *or* Spray lice on underside of leaves with nicotine sulfate 2 teaspoons to 1 gallon soapy water (see page 54)
CUTWORM (Fig. 12)	Fleshy caterpillars which cut off plants at surface of ground. Hide in soil during the day	Prevention—Wrap 4-inch collar of paper around the stem when transplanting; *or* Scatter poisoned bran mash during evening when worms are observed (see page 60)

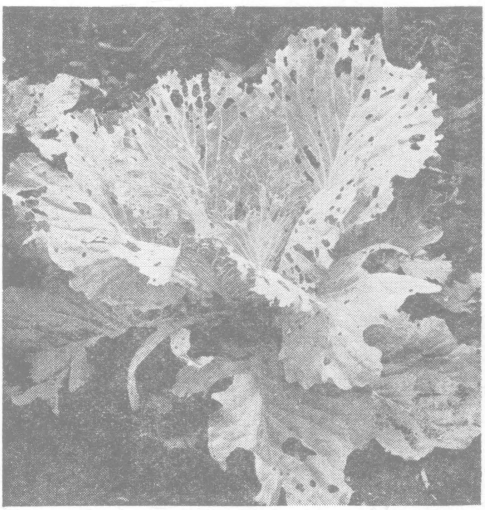


Fig. 11.—Imported cabbage worm injury.

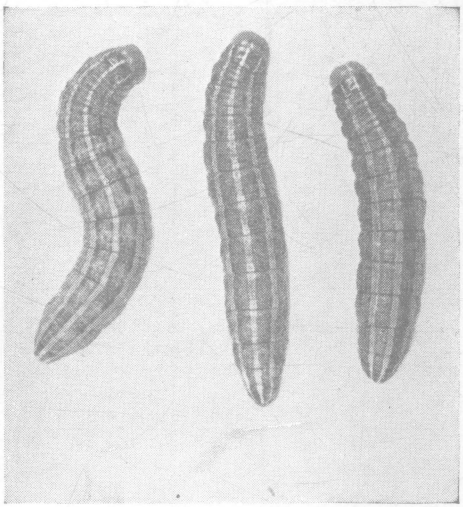


Fig. 12.—Full grown cutworm larvae.

CABBAGE AND CAULIFLOWER (Continued)

Insect or Disease	Description	Remedy or Prevention
ROOT MAGGOT	White maggots which feed upon sides of stem beneath ground, causing plant to wilt	No remedy after maggots appear Dusting the soil lightly about the plants with 5% chlordane dust is said to prevent injury; *or* Use a solution of corrosive sublimate 1 oz. to 10 gals. of water as given on page 59. Begin 4 days after transplanting and repeat in 10 days
HARLEQUIN CABBAGE BUG (Fig. 13) *(Southern Ohio)*	Plant bugs about ⅜ inch long, mottled with red, black, orange, or yellow Suck sap and kill plants	Spray bugs with strong rotenone, using neutral soap as a spreader (see page 51); *or* Spray or dust bugs with DDT (page 52) Hand pick old bugs on cabbage in May
Blackleg	Dark, sunken, circular to oval or irregular areas with many black dots on stems and leaves. Stems may be girdled near ground line and plants wilt and die	Purchase disease-free seed Use hot water seed treatment (see page 64) Sow seed, set plants in disease-free soil Use manure without cabbage refuse Remove and burn diseased plants Use a 4-year rotation
Black rot or blight (Fig. 14)	Dwarfed or one-sided plants with yellow to brown leaves which shrivel and drop off. Blackened vascular ring in stem, and leaf veins black. Head may decay and fall off in a foul mass	Use only disease-free seed Last four measures under *Blackleg* Keep down insects
Club root (Fig. 15)	Stunted, sickly plants which wilt on sunny days. Roots malformed and greatly enlarged	Measures under *Blackleg* Apply fresh hydrated lime, 10 lbs. to 100 square feet, and work into first 4 inches of soil 2 to 4 weeks before planting. Control usually mediocre

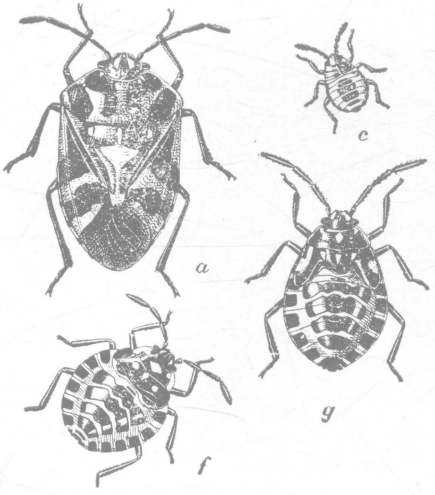


Fig. 13.—Harlequin cabbage bug; (*a*) adult, (c,f,g) stages of young bugs.

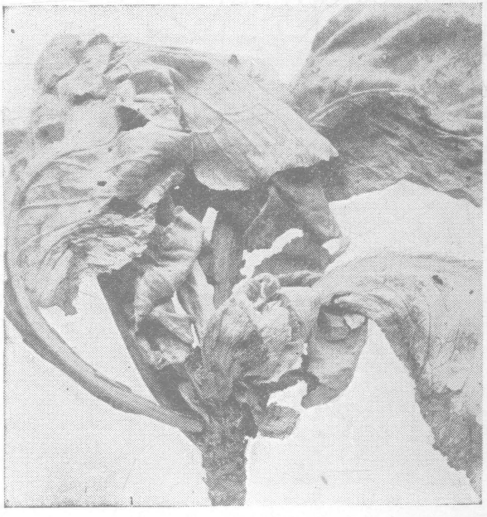


Fig. 14.—Black rot of cabbage.

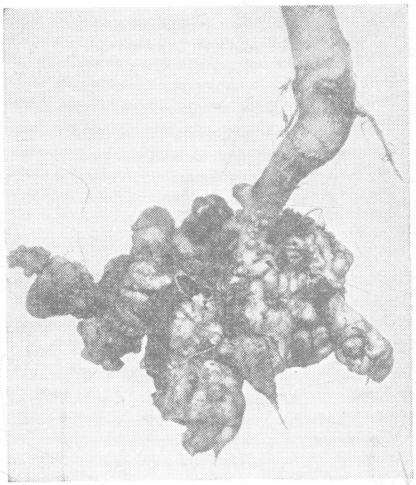


Fig. 15.—Club root of cabbage.

Fig. 16.—Cabbage yellows or fusarium wilt.

Insect or Disease	Description	Remedy or Prevention
Yellows or Fusarium wilt (Fig. 16)	Plants stunted, yellowish-green, often one-sided. Lower leaves drop off, leaving bare stem and small head bitter to the taste; usually does not rot as in *Black rot.* Stems with darkened rings inside	Plant in new location; *or* Grow one of the *Yellows* resistant varieties listed here in order of maturity (early to late); Wisconsin Golden Acre, Racine Market, Jersey Queen, Marion Market, Globe, Wisconsin All-Season, Wisconsin Hollander, Bugner

Fig. 17.—Carrot leaf spot.

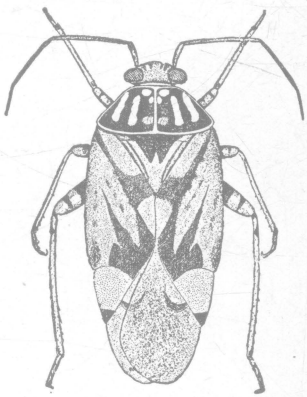


Fig. 18.—Tarnished plant bug. (From Ill. Agr. Exp. Sta.)

CANTALOUPE

Insect or Disease	Description	Remedy or Prevention
See Muskmelon	See Muskmelon	See Muskmelon

CARROT

Leaf spot (Fig. 17)	Dark spots on leaves and petioles which yellow and die if infection is severe. Top and root growth both reduced	Five sprays at 10-day intervals, beginning when plants are 6 inches tall; using bordeaux 6-6-100; or fixed copper 4-100; *or* Zerlate, Dithane Z-78, *or* Parzate at 2-100 Fixed copper plus talc dust (14-86) may be used but less effective

CELERY

SLUGS	Large, slimy or mucus covered snail-like creatures 2 to 5 inches long, grayish brown spotted with black, and provided with two fleshy "horn-like" appendages Feed at night and leave a "silvery" trail on ground or walk	Clean up hiding places such as loose boards, flat stones, flower pots, or dense mulch in vicinity of damaged plants Collect slugs at night with aid of flashlight Use metaldehyde bait sold commercially
APHIS	Plant lice which attack plants in field. May continue to damage celery in storage before marketed	Dust insects with nicotine dust (see page 54); *or* Spray lice thoroughly with nicotine spray (see page 54)
SPITTLE BUG	Frothy masses of "spittle" at base of plant. Mass contains a wingless sucking insect	Spray with benzene hexachloride at rate of 2 tablespoons to 1 gallon of water (see page 59) Avoid applying within 10 days of harvest

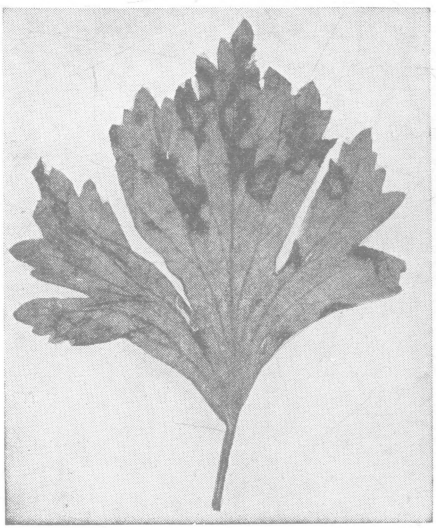


Fig. 19.—Early blight (Cercospora) on celery.

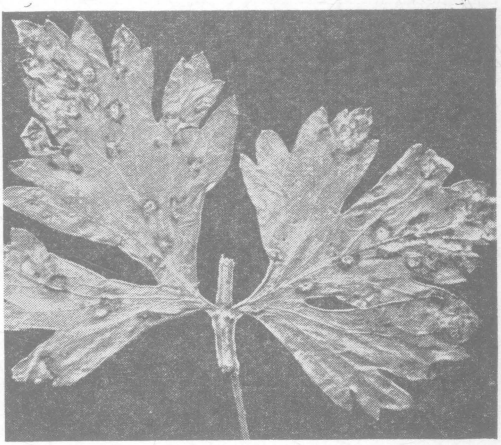


Fig. 20.—Septoria (leaf spot) on celery.

CELERY (Continued)

Insect or Disease	Description	Remedy or Prevention
TARNISHED PLANT BUG (Fig. 18)	Active plant bug about ¼ inch long, brown mottled with shades of red and yellow. Flies away when disturbed Bug punctures stalks near the joint and causes dark spots to appear	Do *not* allow weedy borders or tall grass close to celery planting Spray or dust plants with DDT (page 52), *or* with methoxychlor (page 60)
Early blight (Cercospora) (Fig. 19)	Ash-gray, irregular, velvety, dead areas on leaves and leaf-stalks. Entire leaf may be killed. Infected areas larger than in other blights	Use new soil for seedbed Treat seed (see page 62) Fixed copper 4-100 spray *or* 14-86 fixed copper-talc dust; *or* bordeaux mixture 8-8-100 at 6-day intervals *or* Spray with Zerlate, Parzate or Dithane Z-78 at 2-100, *or* dust 8-92
Leaf spot (Septoria) (Fig. 20)	On leaves and leaf-stalks dead, brown spots containing black dots. Later, entire leaf may be killed	The addition of sulfur to all formulas at 6 lbs. in 100 gals. of spray, or to replace 20 lbs. of talc in dust formulations is suggested as likely to increase yields
Fusarium wilt or Yellows	Plants turn yellow, are stunted; stalks brittle and bitter to the taste	Grow wilt-resistant varieties — *Yellow strains* are: Forbes Golden Plume, Florida Golden. *Green strains* are: Utah, Paragon, N. Y. 19, Early Green, and Sweetheart Use 4 to 5 yr. rotation

CHRYSANTHEMUM

APHIS	Green or black plant lice that cluster on stems	See Bean aphis
COMMON STALK BORER	See Dahlia	See Dahlia
Verticillium wilt	Lower leaves wither and remain attached to the stems. Plants may wilt during bright days	Sterilize soil Plant resistant varieties Destroy diseased plants
Leaf spot (Septoria)	Dark spots starting on lower leaves. Entire leaves brown and disease progresses to those higher on stem	Use sulfur-Fermate dust, *or* sulfur spray or dust at weekly intervals beginning about July 1st

CORN (SWEET)

CUTWORM (Fig. 12)	Fleshy caterpillar that cuts off the corn at surface of ground. Hides in soil during the day	Use poisoned bran mash when worms are noticed (see page 60)

Fig. 21.—Method of treating to control earworm.

Insect or Disease	Description	Remedy or Prevention
CORN EARWORM (Figs. 21, 60)	Greasy, green worm that destroys developing kernels. Feeds rarely on stalk or cob. Length 1½ inches when full grown Most injury occurs to late corn	Dust green corn silk with 5% DDT. Repeat in 4 days to cover new silks; *or* Inject 16-20 drops of highly refined white-oil containing pyrethrum extract into the base of the 6-day old silk, or when the first wilting appears on the edges and tip of silk. A standard medicine dropper injects right amount at one compression

Fig. 22.—Army worms feeding on corn.

Fig. 23.—Sod webworm. (*a*) webbed bag containing larva, (b,c) showing damaged plant.
(From Ill. Agr. Exp. Sta.)

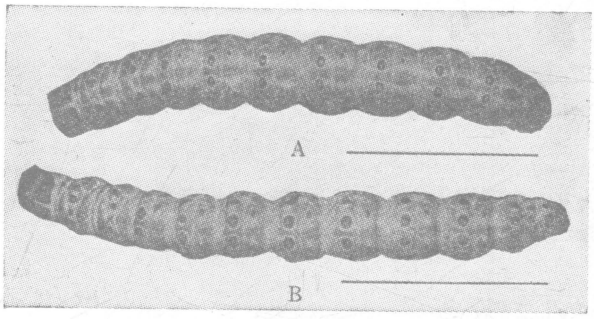


Fig. 24.—Corn borer (*a*) ; smartweed borer (*b*).

Insect or Disease	Description	Remedy or Prevention
EUROPEAN CORN BORER (Fig. 24)	Caterpillars ¾ to ⅞ inch long when full grown; head dark brown, body cream color with light brown markings. Worms burrow through stalks and ears. Infested plants first detected by "pin-hole" feeding marks in leaves. Seriously infested stalks collapse before mature Eggs are laid on undersides of leaves	Avoid very early and very late planting to dodge the insects Dust from above with 5% DDT (see page 52). Applications should begin when first eggs are ready to hatch in June and repeated 3 times at 5-day intervals. This can be expected to give 80-90% control For home garden, and valuable early plantings where market price is likely to be high, spray with 2 lbs. ground derris or cube root, or 1 lb. of 50% DDT powder in 50 gals. of water to which has been added 5 oz. Grasselli spreader-sticker, Areskap, or Ultrawet. Recommended principally for commercial growers who have power sprayers
COMMON STALK BORER (Fig. 28)	Light brown or purplish-brown worms marked with stripes on anterior one-third and posterior half of body. Bores into stalk, causing stem to die	No remedy except to pull up and burn infested plants when stalks wilt Keep weeds and coarse grass mowed in vicinity of garden. Stalk borers develop in bluegrass stems and succulent weeds
ARMY WORM (Fig. 22)	Brown striped caterpillars. Eat plants above ground during day. Hide in soil at night	Use poisoned bran mash when worms appear (see page 60)
SOD WEBWORM (Fig. 23)	Small active worm that lives in webbed retreat in soil at base of plant Devours leaves and cuts off stems	For small patch, dig out and destroy worms when injury appears Replant between rows, not destroying old plants. If first planting has been destroyed, delay replanting
SEED CORN MAGGOT	White maggots that destroy germinating kernels in ground	Avoid applying stable manure to seedbed the fall or spring before planting Plant seed shallow if spring weather is cold

CORN—SWEET (Continued)

Insect or Disease	Description	Remedy or Prevention
GRASSHOPPERS (Fig. 25)	Need no description Damage in Ohio is largely limited to edges of corn fields joining pasture or grassland	Spray or dust corn and margins of field with chlordane. This is sold for grasshopper control and is very effective (see page 59) *or* Scatter poisoned bran mash (see page 60)
ROOT APHIS	Bluish-gray lice that feed on roots	Rotate crops Cultivate frequently to discourage ants which attend them
ROOT WORM	Threadlike yellow-white worm about ½ inch long and having brown head and thorax. Bores into tender stalk near ground surface and severs fibrous roots below ground	No good remedy Do not plant corn on ground occupied by corn the year previous
SAP-FEEDING BEETLES *(Nitidulids)*	Small black, or spotted beetles that feed on sap in kernels of damaged ears Slender white larvae are reared in these locations	Beetles gain access only to ears that have been affected by earworms, borers, or damaged by birds or rodents. If entry is gained they often attack the undamaged kernels No control except to prevent injury by earworms, corn borers, birds or rodents

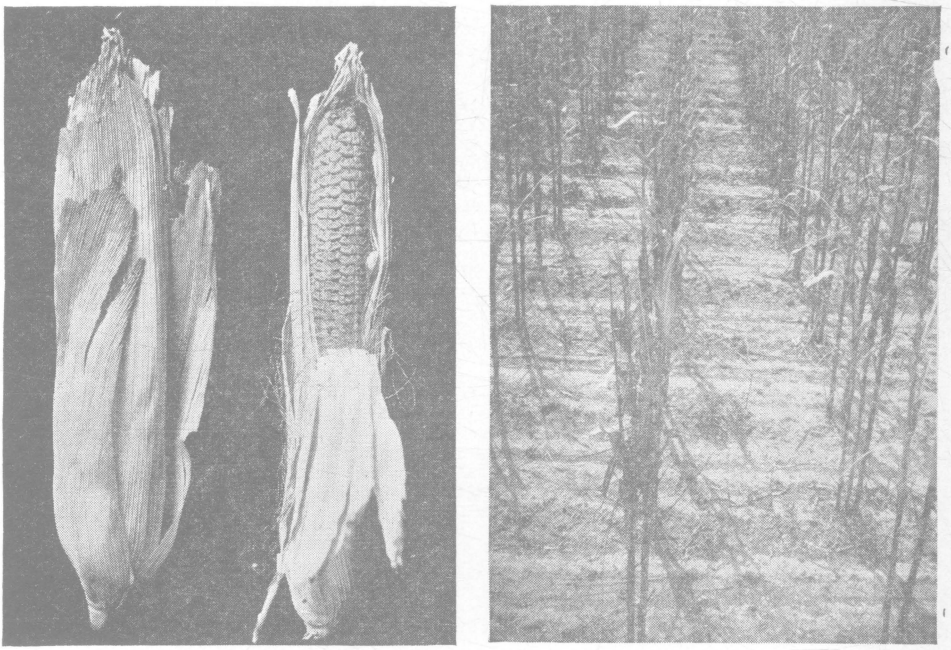


Fig. 25.—(*a*) Results of grasshoppers devouring the corn silk before pollination occurred. (*b*) Corn stripped of leaves by grasshoppers.

CORN—SWEET (Continued)

Insect or Disease	Description	Remedy or Prevention
Bacterial wilt	Plant is stunted, wilts during day, forms tassel early, which turns white and dies. Leaves die, dry out, but remain pale green; soon entire plant dies. Small drops of yellow sticky ooze form at base of stalk if cut across and squeezed. Lower nodes of stalk brown inside	Destroy diseased plants when first noticed Use wilt-resistant hybrids, or varieties such as: Spancross, Whipcross, Marcross, Golden Cross Bantam, or Ohio Gold Use at least a 3-year rotation Avoid use of manure with corn refuse Use a complete commercial fertilizer liberally when preparing seedbed
Smut	Large smut balls on tassel, stem, leaf, or ear, at first glistening white then blackish, finally bursting and exposing black, dusty spore mass	Rotate crops Avoid use of smut contaminated manure Seed treatment is of no value for smut control Avoid varieties known to be especially susceptible
CUCUMBER		
PICKLE WORM (Southern Ohio only)	Greenish-white or yellowish-white larva ½ to ⅝ inch long when full grown. Burrows into pickles	Plant pickles early to avoid damage. Can be killed with cryolite (see page 59), *or* methoxychlor (page 60), *or* with DDT (aerosol grade) spray or dust (see page 52). Commercial (technical) DDT injures some varieties of cucumbers and should *not* be used. Apply before worms leave the flowers Destroy old vines soon after harvest
CUTWORMS	See Corn	Use poisoned bran mash (see page 60) when worms appear Plant seed thick and thin out later
12-SPOTTED LEAF BEETLE (Fig. 26)	Green beetles with 12 black spots on wings. Eat holes in leaves	Same measures as for Striped cucumber beetle (see page 19)
SEED MAGGOT	Maggots that destroy germinating seed	See under Bean (page 8)

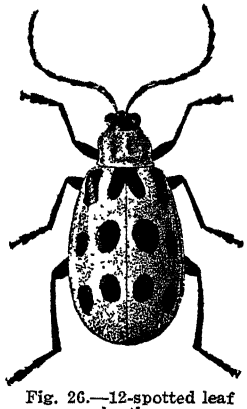


Fig. 26.—12-spotted leaf beetle.
(From Ill. Agr. Exp. Sta.)

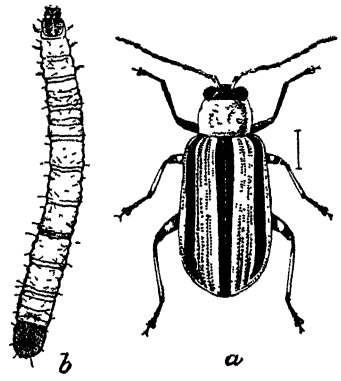


Fig. 27.—Striped cucumber beetle: (*a*) adult, (*b*) larva.

CUCUMBER (Continued)

Insect or Disease	Description	Remedy or Prevention
APHIS	Small green plant lice that suck sap on underside of leaf causing leaf to curl	Turn over infested vines and spray insects with nicotine sulfate 2 teaspoons to 1 gal. soapy water; *or* Dust with nicotine dust (see page 54) Carefully remove and destroy the first vines found infested to prevent spread
CUCUMBER BEETLES (striped) (Fig. 27)	Small yellow and black striped beetles that eat holes in young leaves and cut off stems. Beetles spread wilt disease Larvae are elongated and infest the root-stalk	Plant a surplus of seed and thin out later Dust plants as soon as they come up and at 5 or 6 days intervals (repeat application after rains) with: commercially prepared fixed copper-rotenone-talc (10-15-75) mixture; *or* Dust with Zerlate-rotenone-diluent (10-15-75) also commercially prepared *Note:* If the above dust combinations are not available, either rotenone, methoxychlor (see page 60), or aerosol grade DDT (page 52) should be used alone for striped cucumber beetles while plants are small. Do not spray or dust cucumbers or melons with the commercial grade of DDT (see warning page 52). Then alternate and continue with separate applications of fungicide using Zerlate spray 2-100, or dust 8-92
and *Wilt (bacterial)*	Plants wilt suddenly and die. A whitish, sticky slime oozes out of ends of stems when cut and if permitted to dry for a few minutes will string when touched with the knife blade and slowly withdrawn	
Angular leaf spot	Angular spots, 1/15 to 1/8 inch across, at first water-soaked, later they dry and drop out	Treat seed (see page 62) Dust as for bacterial wilt Rotate crops
Anthracnose	Brown spots 1/4 to 1/2 inch across on leaves which may be killed. Also elongated sunken cankers on stem. On the fruits, sunken circular to irregular cankers with dark margins and pink centers	Treat seed (see page 62) Same measures as for *Wilt*, but change to 4-4-100 bordeaux mixture late in the season if leaf spots appear Rotate crops
Downy mildew	Yellowish angular areas on upper sides; white to purplish downy growth on lower side of leaves, which may curl, turn brown and die in a few days	Dust as for *Wilt*
Mosaic (white or little pickle)	Stunted yellow plants; mottled leaves; mottled, warty pickles	Eradicate wild cucumber, milkweed, groundcherry, catnip, and pokeweed plants from adjacent areas before cucumbers come up Plant Shamrock for slicing, or Ohio 31 for pickles if tolerance to this disease is desired Keep down insects and rotate crops

CUCUMBER (Continued)

Insect or Disease	Description	Remedy or Prevention
Copper injury (Fig. 37)	See Melon	See Melon
Scab	Leaves with water-soaked spots; often wilt. On fruit, small gray, slightly sunken lesions which ooze drops of sticky fluid. The canker grows larger and deeper and becomes lined with a dark-green velvety layer of thread-like fungus	Treat seed for 5 minutes in corrosive sublimate 1-1000 (see page 62) Dust as for *Wilt* Plow under cucumber vines as soon as harvest is completed Practice a long crop rotation

CURRANT

CURRANT WORM	Green worms that devour the leaves	Spray or sprinkle with ground derris or cube root (rotenone) 3 level tablespoons to 1 gal. water when worms are noticed (1 pint to 9 gals.) (page 51); *or* Dust with 0.75% rotenone dust (see page 51)
APHIS	Leaves crimped and curled by yellowish green plant lice on lower surface	See aphis under Bean (see page 8)
CURRANT STEM GIRDLER	Tips of canes become girdled and grubs bore in the pith below point of girdling	During May and June cut off and burn the injured shoots 3 or 4 inches below point of girdling
Anthracnose, Septoria and Cercospora leaf spots	Small dark brown spots on leaves which often turn yellow and fall Also attack berries, fruit-stalks and young canes	Spray with bordeaux mixture 4-6-100 (see p. 55) or lime-sulfur solution 1½-100, *or* Dust with finely ground sulfur 90 parts and lime 10 parts Make five to six applications beginning when leaves are unfolding and at intervals of 10 to 14 days

DAHLIA

COMMON STALK BORER	Borer enters stem through a round hole and tunnels the center, causing wilting	No effective remedy after infested Keep coarse weeds and grass cut near the flowers Destroy infested stems

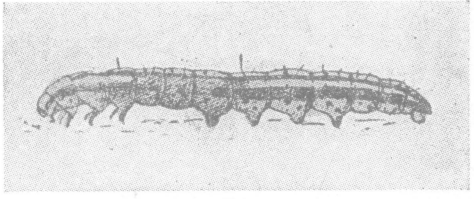


Fig. 28.—Common stalk borer.

DAHLIA (Continued)

Insect or Disease	Description	Remedy or Prevention
BLISTER BEETLE	See Aster	See Aster
TARNISHED PLANT BUG	Brown bugs about ¼ inch long that fly away rapidly. Bugs puncture and deform flower buds	Dust with DDT (see page 52)
LEAFHOPPER	See Aster	Dust with DDT (see page 52)
ROSE CHAFER	See Rose	Dust with DDT (see page 52)
Virus (Mosaic) (Spotted wilt)	Plants stunted, bushy, and foliage yellowish-green or mottled. Sometimes ring-spot symptoms	Dig up and discard infected clumps as soon as noticed Do not plant tubers from infected plants Control thrips and leafhoppers with DDT
Mildew	White powdery spots appear on upper surface of leaves	Apply sulfur dust, or wettable sulfur spray every 7 days beginning as soon as first spots appear

DELPHINIUM OR LARKSPUR

Crown rot	Lower leaves turn brown and after several days one or more of the flower stalks are dry and dead. Especially severe during cold wet weather	Remove diseased plants and drench soil around crowns of remaining plants with corrosive sublimate 1-2000 If the majority of the plants in a bed are infected, sterilize the soil with formaldehyde, or change soil to a depth of 10 inches
Bacterial blight (Fig. 29)	Black irregular spots on upper surface of leaves, on petioles, stems and flowers; brown on lower leaf surface. Lower leaves infected first and disease gradually progresses upward until the entire stalk is killed	Drench soil around crowns with 8-8-100 bordeaux mixture as growth starts in spring. Spray young shoots with same mixture just after emergence In e arly fall cut off the old tops and burn; drench soil around crowns with corrosive sublimate 1-2000

Fig. 29.—Bacterial blight on delphinium.

Fig. 30.—Aphis on eggplant.

EGGPLANT

Insect or Disease	Description	Remedy or Prevention
FLEA BEETLE (Figs. 31,32)	Small black jumping beetles that eat round holes in leaves	Spray or dust with rotenone (page 51), or fluorine compound (page 59), or DDT (page 52) as soon as noticed
POTATO BEETLE	See Potato	See Potato
SPINACH APHIS	Greenish-yellow plant lice that suck the sap from undersides of leaves	Spray with nicotine sulfate solution 2 teaspoons to one gallon of soapy water (page 54). Strike insects with the spray
Phomopsis blight	Seedlings may rot off at surface of ground; on older plants a constricted canker or gray dry rot develops on the stem; clearly defined, circular, gray to brown areas on the leaves. Fruit lesions light brown, nearly circular and slightly depressed; later dark brown, enlarged sometimes 2 to 3 inches and are studded with small black dots	Treat seed (see page 62) Spray plants in the field with 6-6-100 bordeaux as soon as established in the field and weekly thereafter for 5 to 7 weeks; *or* Use commercially prepared dust mixture of fixed copper-rotenone-talc (10-15-75) as recommended under cucumber, *or* Spray with 3 lbs. fixed copper (50% metallic) in 100 gals. water
Leaf spots and fruit rots	Various: Any not included in above	Spray or dust with fixed copper formulas as for *Phomopsis blight*
Verticillium wilt	Plants stunted, later may wilt during heat of day; leaves, lower ones first, turn yellow, then brown between veins. If stem is cut lengthwise vascular tissue will be dark	Treat seed (see page 62) Use long rotation which does not include tomatoes, potatoes, or raspberries Do not place manure with vegetable refuse on land which is to be planted with eggplant

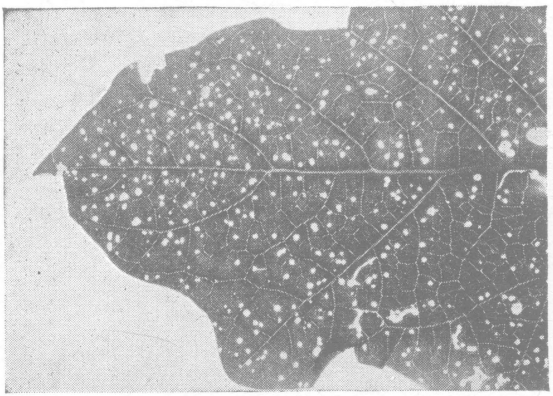


Fig. 31.—Flea beetle injury to eggplant.

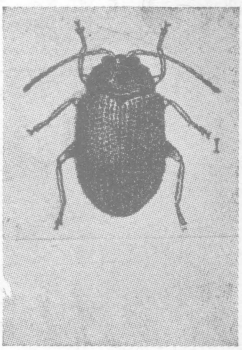


Fig. 32.—Flea beetle (enlarged).

Fig. 33.—Cases enclosing bagworms

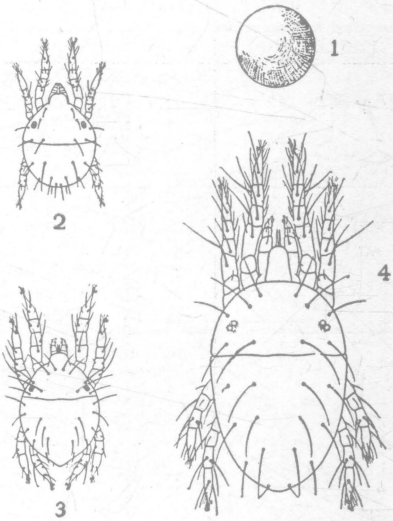


Fig. 34.—Stages of red spider, from egg to adult.

EVERGREEN (Arbor-vitae)

Insect or Disease	Description	Remedy or Prevention
BAGWORM (Fig. 33)	Brown larva encased in a small conical bag or covering made of fragments of leaves. Feeds on foliage	Hand pick and destroy bags with larvae when insects first appear On larger plantings, spray with 6 level teaspoons lead arsenate in 1 gallon water
RED SPIDER (Fig.34)	Very small mites that feed upon foliage, causing "rusty" appearance of same	Drench plants frequently with strong stream of water from a hose; *or* Dust plants with powdered sulfur when spiders first appear; *or* Spray plants with 1 level tablespoon of 25% parathion powder in 3 gals. water
DROUTH AND WINTER INJURY	Leaves and small branches turn brown and die. Larger branches and sometimes an entire side may be involved	Do not plant arbor-vitae in dry, hot locations. If possible plant in semi-shade and at least 6 ft. from the house. Cover ground around tree with peat moss or woods mold, and water thoroughly weekly when dry. Fall watering is important
Fall Browning	Some leaves brown and drop in fall of year	No remedy required. It is normal for arbor-vitae to shed some leaves each fall

GLADIOLUS

THRIPS (Fig. 35)	Very small, active, black insects that feed under leaf sheath, causing plants to be stunted and flowers deformed	Sprinkle one tablespoon of 3 or 5% DDT dust over each peck of corms to be stored and shake in a bag; *or* Immerse infested corms with corrosive sublimate solution 1-1000 for 12 to 17 hrs. just before planting If plants become infested, spray or dust with DDT at weekly intervals (see page 52)

GALDIOLUS (Continued)

Insect or Disease	Description	Remedy or Prevention
Dry rot	Stems may rot off below the surface of the ground. Corm lesions difficult to distinguish from *hard rot*	Follow suggestions for *Scab* and *Hard rot*
Penicillium rot	Sunken lesions, brown outside, gray within. Causes a firm porous rot throughout corm. A green mold may spread over lesions	By avoiding injury through digging, this disease can be largely eliminated. Store at 35° to 40°F. in a dry location. Sort out all rotted corms in storage
Scab	Minute reddish-brown spots on lower portion of leaf blade. Corm lesions are shallow, circular, brown to black in color, with raised margins and varnish-like centers	Remove all husks in spring before planting. Discard all corms which show severe spotting Treat corms in a solution of corrosive sublimate 1-1000 for 2 hours just before planting Plant in soil which has not grown gladioli for 4 years
Hard rot	Spots on leaves circular or oval, brown or purplish-brown in color. Minute black dots in center of older spots Lesions on corms in fall are small, appear water-soaked, brown to brownish-black in color, and not visible unless husks are removed	Rake up and burn all tops left on ground. Also follow remedies suggested under *Scab*
Fusarium basal rot	Brown depressed areas at base of corm	Dowicide B, 6 oz. in 3 gals. water; *or* New Improved Ceresan (1 oz. plus 2 tablespoons Dreft in 3 gals. water) 15 mins. Plant immediately

Fig. 35.—Gladiolus thrip.

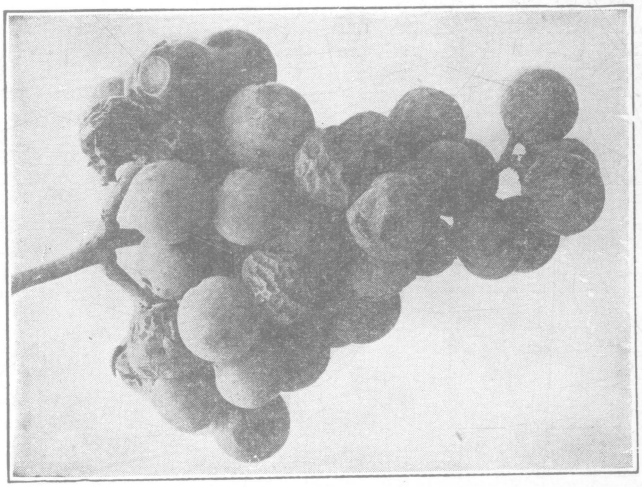


Fig. 36.—Grapes injured by berry-moth larvae.

GOOSEBERRY

Insect or Disease	Description	Remedy or Prevention
Powdery mildew	White mildew growth on leaves and young stem tips, later brown with black specks	Spray wth wettable sulfur, or dust with 90-10 sulfur-lime dust when buds begin to open and at intervals of 2 weeks (page 55). Make five applications
Other diseases and insects	See Currant	See Currant

GRAPE

GRAPE BERRY-MOTH (Fig. 36)	Small worm which develops in fruit, causing it to color prematurely. Infested berry later cracks open or shrivels and drops from bunch	Spray one week after bloom, again 2 weeks later, and again about Aug. 1st with ½ lb. of 50% DDT (1 lb. 25%) in 25 gals. water, or in bordeaux mixture (see under *Black rot*, page 26). DDT can be used with Fermate if that fungicide is selected Refer to Ext. Bul. No. 128, 1949, for commercial vineyards
GRAPEVINE FLEA BEETLE	Small steel-blue beetles that eat the opening buds in spring and destroy the new growth The dark-brown larvae feed upon upper surface of the leaves in June	Spray or dust with DDT, strength same as for berry-moth, if beetles are seen on buds in May, or grubs are feeding in June
CLIMBING CUTWORMS	Brown cutworms that hide under trash near bottom of canes by day and feed on the buds by night	Dust 5% DDT on ground around base of plant and on grape cane near ground as first injury to buds is detected
GRAPE ROOT WORM	Small grayish-brown beetles which eat chain-like marks in the leaves in June and July Larvae feed on roots of grape	Spray foliage with DDT, 1½ level tablespoons, or lead arsenate 4 level tablespoons to 1 gal. water (1 pint to 8 gals.) in June when beetles are first noticed Cultivate soil thoroughly to kill pupae late in May and early June
ROSE CHAFER (rose bug)	Long-legged, yellowish-brown beetles about ½ inch long. Eat blossom buds, newly set fruit and foliage	Spray or dust with DDT at same strength as for berry-moth. (See berry-moth above)
LEAFHOPPER (Fig. 41)	Very small elongate insects marked with yellow and red, which jump from the leaf when disturbed Suck the sap from underside of leaf. Cause speckled appearance of leaf which turns brown	Spray or dust underside of leaves with DDT as soon as insects are noticed (see page 52) Treatment recommended for berry-moth controls leafhoppers

GRAPE (Continued)

Insect or Disease	Description	Remedy or Prevention
Black rot	At first a small white spot, later surrounded by a brown band on the green berries. Soon the berry turns black, shrivels, and is covered with black pimples On green leaves, light-brown circular spots with dark margins and black dots near the edge Reddish-brown elongated lesions on new canes	Spray with bordeaux mixture (see page 55) 8-8-100, *or* with Fermate 2 lbs. to 100 gals. water when new shoots are ½ to ¾ in. long. Again with bordeaux mixture 6-6-100, or with Fermate (2 lbs.) when shoots are 10 to 12 in. long. Apply a 3rd spray when very first bloom appears, and a 4th just after bloom using fungicide as recommended in the 2nd spray. All 4 sprays are needed for effective control of *Black rot* Include 2½ qts. summer spray oil in *pre-bloom* sprays if bordeaux is used Include insecticide in *post-bloom* sprays. (Note berry-moth, page 25) Use either a straight schedule of bordeaux, *or* Fermate as the fungicide
Downy mildew	Leaves with indefinite yellowish areas above; white downy patches beneath. Young shoots covered with white downy growth	Same *timing* schedule as for *Black rot* except bordeaux mixture should be chosen as the fungicide
Powdery mildew	White powdery patches on leaves, fruits and canes may occur throughout growing season. Later, black specks dot the white patches	Same control measures as for *Downy mildew*

GRASS (Lawn)

EARTHWORMS	Need no description	Dissolve 2 oz. corrosive sublimate (poison) in 50 gallons water and sprinkle over 1000 sq. ft. of infested sod. Water lawn immediately; *or* Apply lead arsenate, or DDT as for WHITE GRUB (see page 27)
ANTS	Need no description	If ants have constructed large mounds, sift 10% DDT powder over surface of ant-hill. Repeat after each rain *or* Thrust a small stick about 3 or 4 inches into the center of mound and insert about a teaspoon of paradichlorobenzene crystals. Then fill hole with earth If ants are small and nests are not easily located, scatter lightly DDT or 5% chlordane dust over the grass
SOD WEBWORMS (Fig. 23)	Small active larvae that cut off grass at ground surface causing dead areas in lawn. Larvae live in webbed retreats	Try treatment of DDT as given under WHITE GRUB (see page 27)

GRASS—LAWN (Continued)

Insect or Disease	Description	Remedy or Prevention
WHITE GRUB (Fig. 1)	Large, white, fleshy larvae with hard, yellow heads. Live underground among roots. Cause dead spots in lawn	Where sod has not been killed, top dress lawn with either 10 lbs. of lead arsenate, 5 lbs. of 50% DDT pwd., or 5 lbs. of 40% chlordane pwd. per 1000 sq. ft. Mix the insecticide with 1 bu. of sifted soil and scatter broadcast over lawn. Wash the mixture down with stream of water from hose If sod is killed by grubs, spade up and destroy grubs by working above mixture into upper inch of soil and reseed
JAPANESE BEETLE LARVA	Resembles white grub except smaller	
MOLES	Need no description	Trap with mole traps: choker loop or scissors type traps preferred May be driven from small areas by applying 1 teaspoon of either calcium cyanide, flake napthalene, or household lye in mole runway at intervals of about 20 ft. Apply lead arsenate as for WHITE GRUBS Frequent rolling of lawn discourages them

IRIS

IRIS BORER	Large cream to pinkish colored caterpillar spotted on sides. Tunnels through larger roots, causing them to decay and plants to die	Destroy old top growth in early spring Cut away and remove leaf fans showing early feeding work, which removes young borer with it and prevents root damage during May or early June Reset plants in July every second year
Leaf Spot	Small brown spots, surrounded by water-soaked markin on the leaves. These spots enlarge, frequently killing the entire leaf. The centers of older spots turn gray and are dotted with small black fruiting bodies	Cut off the old leaves at the ground line in the fall and burn them
Crown rot	Tips of outer leaves die, moving downward until entire leaf is dead. As rot progresses inward at base of plant the leaves collapse White fungus growth —later brown—may be seen between leaves near ground line. Rhizomes are not destroyed but weakened	Take up infected plants and wash rhizomes in corrosive sublimate solution 1-1000 (see page 62) and plant in clean soil Do not permit crowding of plants
Soft rot	At first leaves wilt slightly, later become limp and die. Rhizome shows a soft slimy rot and later turns dry and granular, finally decaying entirely	Severely infected plants should be dug up and burned. If rhizome is slightly rotted, cut away rotted portion, dip remainder in corrosive sublimate solution 1-1000 (see page 62) and plant in clean soil Follow recommendations about resetting under IRIS BORER

LETTUCE

Insect or Disease	Description	Remedy or Prevention
SLUGS	See Celery	See Celery
APHIS	Green lice that feed upon leaves	Spray lice with pyrethrum or nicotine sulfate
Drop	A soft water-soaked spot on stem near the ground. The rot grows downward, killing the roots, and upward, rotting the bases of the outer leaves, and causing a soft rot of the inner ones. The entire plant looks as if it had been "dropped"	Rotate crops, but do not use celery or cabbage in rotation Keep surface of the soil dry by frequent cultivation In the greenhouse sterilize with steam, or formaldehyde (see page 63) If few plants are infested remove and soak the soil wtih copper sulfate solution 1 lb. to 7 gals. water Keep house clean
Gray mold (Botrytis)	Water-soaked dark areas on lower leaves or stem. In a day or two entire plant is reduced to a rotted slimy mass covered with a gray mold	Same measures as for lettuce *Drop* Dust with Thiosan (50%) at the rate of 1½ lbs. per 1000 sq. ft. (diluted 1-1 with talc). Apply at weekly intervals for 8 applications beginning at the seedling stage

MELON (MUSKMELON AND WATERMELON)

STRIPED CUCUMBER BEETLE (Fig. 27)	See Cucumber	See Cucumber
LEAF BEETLE (Fig. 26)	See Cucumber	See Cucumber
APHIS	Small, green plant lice on underside of leaves. Cause leaves to wilt and vine to die	Pull up carefully, and bury or remove the first plants damaged and covered with plant lice. Do not drag infested plants through field; *or* Spray as for cucumber aphis
CUTWORM	Fleshy larvae that cut off plants	Place poisoned bran mash around melon hills where cutworms are present (see page 60)
Anthracnose (Fig. 38)	Angular black lesions on watermelon leaves; reddish brown on muskmelon. Infected small fruits turn black and fall off. On older fruits, light gray spots, dark margins, pink centers	Treat seed (see page 62) Spray, when runners begin to form and thereafter at weekly intervals with fixed copper (3-100), or with Zerlate (2-100); *or* Dust with a 4 or 5% fixed copper dust, *or* 10-90 Zerlate-filler dust Rotate crops
Copper injury (Fig. 37)	Yellow band sometimes an inch wide forms around the edge of leaf, due to excess copper spray or dust	Most likely to occur when fixed copper is applied during hot, dry weather
Downy mildew	See Cucumber	Same as for Anthracnose above
Mosaic	See Cucumber	See Cucumber
Wilt (bacterial)	See Cucumber	See Cucumber

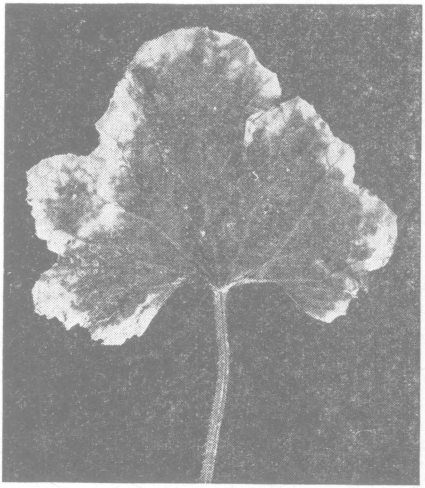


Fig. 37.—Copper injury around leaf.

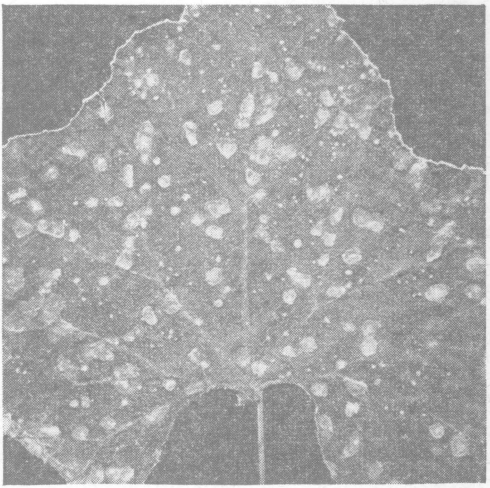


Fig. 38.—Macrosporium leaf blight and anthracnose.

Insect or Disease	Description	Remedy or Prevention
Fusarium wilt of watermelon	Vines turn yellow and wilt about fruiting time. Inside "bark" dark when stem is cut across	Plant resistant varieties like Hawksbury, Improved Kleckly Sweet No. 6, Klondike R7, Iowa King, or Pride of Muscatine
Macrosporium leaf blight (Fig. 38)	Circular, brown spots with concentric rings visible only on upper-side of leaves which curl and dry up	See Anthracnose, page 28

ONION

ONION MAGGOT	White maggots which burrow into the onion bulbs, causing decay	No remedy after insects appear Can be prevented by moistening soil at base of plants with corrosive sublimate solution 1 oz. to 8 gals. water (see page 59). Spray or drip solution to wet soil before eggs hatch and when sets are 1 to 1½ inches high. Repeat 2 or 3 times at 10-day intervals
THRIPS (Fig. 35)	Very small yellow insects which feed upon the surface of the leaves and stems, giving the plants a whitish or blasted appearance Insects are difficult to see	Plant as early as possible As soon as thrips are noticed, spray or dust with DDT (see page 52). Addition of a spreader is desirable. Repeat as necessary Sweet Spanish types comparatively resistant to thrips and *pink rot* Spade or plow as soon as crop is harvested
ZEBRA CATERPILLAR	Yellow and black striped caterpillar that feeds upon tops	Spray or dust with DDT (see page 52) as soon as caterpillars are noticed

ONION (Continued)

Insect or Disease	Description	Remedy or Prevention
Smut (Fig. 39)	Parts of leaves and bulbs of young plants are filled with a black powdery mass	Grow from sets; *or* Sow seed in new seedbed and transplant; *or* After sowing seed and before covering, sprinkle in the row with formaldehyde solution, 1 pint in 16 gals. of water, at rate of 1 pint to 23 feet of row (see page 62) Rotation of crops
Smudge	Black or dark circular or irregular areas on bulbs or neck of onion	Grow colored onions No satisfactory control for white varieties
Neck rot	Sunken, dried-out lesions about the neck. Later, entire bulb may be affected. The inside is soft, light brown, with gray fungous growth between the scales. Black resting bodies of the fungus may form on dried scales	Yellow and Red types rot less than White ones While harvesting, cut tops close and dry stubs before storing. If possible, dry with artificial heat, for 2 to 3 days at 90° to 120°F. Discard thick necks and scallions Store in slatted crates, in a dry, well ventilated storage at 32°F.

PANSY

SLUGS	See page 4	See page 4

PARSNIP

WEBWORM	Pale-gray caterpillar about ½ inch long with black head and short hairs on body. Webs the flower heads together	Cut off and burn all stems with destroyed flowers when damage is first observed Spray or dust with DDT (see page 52), *or* Dust with arsenical
Ramularia leaf spot	Small, irregular, brown spots on leaves; narrow elongated lesions on petioles. A white fungous growth on lower side of leaf often covers the dead areas	Apply 3 to 5 bordeaux mixture 8–8–100 sprays at weekly intervals, when first signs of the disease are noticed (page 55), *or* fixed copper spray 4–100

PEA

APHIS	Pale-green plant lice which suck the sap from the vines and terminal shoots	Dust with 1% rotenone or 5% DDT powder; *or* Spray insects with rotenone spray (page 51) to which has been added a little powdered skim-milk, or a neutral commercial spreader
SLUGS	See page 4	See page 4
Pod spot (Anthracnose) (Fig. 10)	Sunken, gray, circular spots with dark border on pods. Also on stems and leaves	No effective treatment Avoid diseased seed Rotate crops

PEA (Continued)

Insect or Disease	Description	Remedy or Prevention
Root rot and Seed rot	Outer tissue of main roots decay leaving a central core which frequently can be pulled out of the ground in long strings instead of breaking off where the seed was located. Roots blackened	Use clean seed. Plant early in well drained fertile soil Turn under pea refuse promptly and use 3- to 5-year rotation which does not contain alfalfa or sweet clover Treat seed with Spergon, or Arasan (see page 62)
Wilt	Plants stunted, pale yellow-green with leaves curled downward. Stem thickened and brittle near ground. Plants wilt and die prematurely. Roots look healthy unless infected by *root rot*	Use measures under *Root rot* and in addition plant wilt-resistant varieties— *Home garden:* Telephone, Dwarf Alderman, Teton, Asgrow 40 *Canning:* Pride, Admiral, Prince of Wales, Merit; Delwiche Commando is near wilt-resistant
Blight	Purplish to black streak on the stem near the ground. Irregular discolored areas at the nodes. Small, purplish, angular dots on the leaves which may shrivel and die. Pod spots resemble those on the leaves. Young plants may be attacked and killed, sometimes before emergence	Use clean seed produced in the western states Plant in well drained soil using a 3- to 5-year rotation Plow pea refuse under promptly after harvest

PEONY

ROSE CHAFER	Long-legged yellowish brown beetles about ½ inch long that feed upon blossoms	Spray or dust with DDT (see page 52)
ANTS	Clusters on flower buds	These do no harm to buds but feed on sweet secretion
Root knot (Nematodes)	Sprouts weak and spindly Larger roots short, stubby, knotted and gnarled Smaller roots contain many swellings the size of a pea, or BB shot. If a knot is cut across white glistening dots (mature females) may be seen	If roots are lightly infested, set plants in heavy soil. Such plants will probably bloom satisfactorily Discard badly infested roots and plant clean roots in clean soil
Botrytis blight	Young stalks suddenly wilt and fall over. Flower buds may turn dark and dry up; or fail to open. Irregular lesions appear on the leaves. During wet weather, infected areas covered with a brown coat of spores	Remove and burn diseased parts when found Spray ground and shoots as the latter are emerging with 8-8-100 bordeaux mixture. Repeat in a week Cut off and burn old tops in fall Grow varieties resistant to the diesase

PEPPER

Insect or Disease	Description	Remedy or Prevention
COLORADO POTATO BEETLE (Fig. 40)	See Potato	See Potato
FLEA BEETLE	See Potato	Spray or dust with rotenone, or DDT (see pages 51 and 52)
LEAFHOPPERS	See Potato	See Potato
Anthracnose	Tan, dark gray, or black sunken lesions on the fruit. Margins dark-green, water-soaked and wrinkled. Usually many pink dots in the depressed area	Use rotation of crops Turn under crop refuse soon after harvest If the number of plants is small, remove and burn or bury diseased fruits Treat seed (see page 62)
Blossom-end rot	Slight water-soaked depressions at or near blossom-end of half grown fruit. Later this spot enlarges, turns dark, and may involve the entire end of the fruit	See Tomato for control
Alternaria leaf spot	See Tomato	See Alternaria of Tomato, page 46

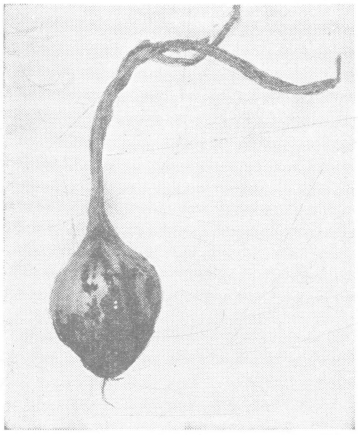


Fig. 39.—Onion smut.

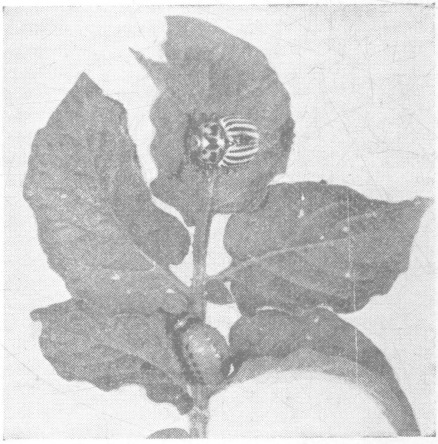


Fig. 40.—Colorado potato beetle and larvae.

POTATO

COLORADO POTATO BEETLE (Fig. 40)	Large striped beetles and red grubs which eat foliage	For small patch: Remove beetles and eggs by hand Spray with DDT (combined with bordeaux mixture if blight is feared); *or* dust with DDT (see page 53) Repeat every 10 days for protection against leafhoppers (see page 33)

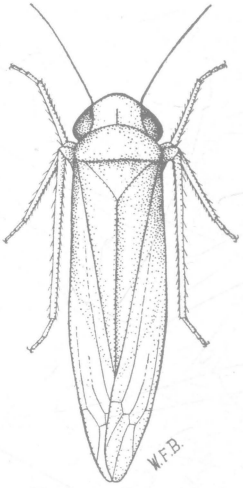


Fig. 41.—Potato leafhopper (enlarged).

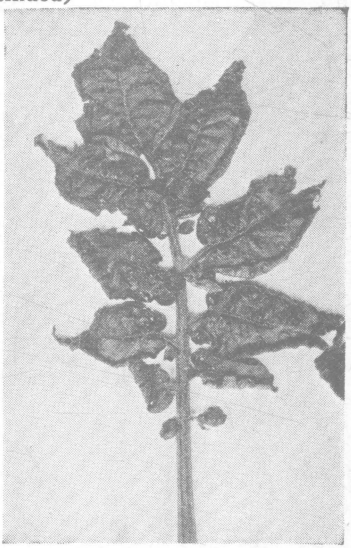


Fig. 42.—Potato leaf injured by potato leafhopper.

Insect or Disease	Description	Remedy or Prevention
FLEA BEETLE (Fig. 32)	Small black, jumping beetles which eat small holes in the leaves	Use DDT as for Colorado potato beetle
APHIS (Fig. 30)	Small pink and green plant lice which suck the sap on undersides of leaves and at tips of plants, causing plants to wilt	Spray insects with nicotine sulfate (see page 54) when lice appear in numbers. Spray from underside and repeat in a few days if necessary. Be thorough
WHITE GRUBS	Large cavities eaten out of tuber (see Fig. 1)	No direct remedy Plow down green legume such as sweet clover, alfalfa or soybeans for potato seedbed
WIREWORM (Figs. 2, 44)	Slender tunnels penetrating deep into tuber	Avoid timothy or bluegrass sod for potato planting. Where this is impossible, avoid planting early
LEAFHOPPERS (Figs. 41, 42)	Small, green, active insects that suck the sap from underside of leaves Cause leaves to turn brown and die, beginning at tip or margin and extending to midrib. Insects cause "hopper-burn" a disease characterized by dead and rolled leaf margins	Spray or dust with DDT (see page 52) when adult insects first appear. Apply to underside of leaves. Repeat at intervals of 10 days until mature Successful commercial potato growers apply a schedule of bordeaux mixture *sprays* combined with DDT (see page 53). These are commenced while plants are young and repeated at 10-day intervals as long as plants are green Commercial potato *dusts* now carry DDT and fixed copper

POTATO (Continued)

Insect or Disease	Description	Remedy or Prevention
STRIPED OR GRAY BLISTER BEETLES (Fig. 4)	Large, elongated striped or gray beetles (old-fashioned potato bugs) that work in colonies and strip a number of plants in a few hours	Arsenicals do not prove satisfactory Spray or dust with fluorine compound (page 59), or with DDT (see page 52)
SEED MAGGOT	White maggots that cause decay of seed tuber in soil	See Corn
MILLIPEDES (Fig. 43)	Small "thousand-legged" worms that eat shallow pits in tubers	No control known
SCAB-GNAT	Tiny white footless larvae found in scab and millipede scars	Prevent scab injury
Early blight (Alternaria)	Circular or irregular brown spots with concentric rings on leaves	Spray with a fixed copper plus DDT (4-1-100), or with Zerlate, Dithane Z-78 or Parzate plus DDT (2-1-100) If dusting is preferred use a fixed copper-DDT-diluent dust (14-6-80); or Zerlate, Dithane Z-78 or Parzate-DDT-diluent (8-6-86)
Late blight (Phytophthora)	Leaves with water-soaked spots ¼ to 1 inch across, dying and turning brown or black. Often with downy growth on lower surface. Whole plants may be blighted. Tubers also affected (see *Dry rot*)	Plant only disease-free tubers Spray with bordeaux mixture plus DDT (8-8-1-100), a fixed copper plus DDT (4-1-100); Dithane 4-14 plus $ZnSO_4$ plus DDT (4-1-1-100); *or* Dithane Z-78 or Parzate plus DDT (2-1-100). Applications every 7 to 10 days beginning when plants are 6 inches high Try such *Late blight* resistant varieties as: Placid, Virgil, Empire, Ashworth and Kennebec
Blackleg (Bacterial)	Stem blackened below or near ground line. Tops small, often turn yellow and wilt suddenly or die gradually	Do not plant any tubers discolored internally Plant seed immediately after cutting

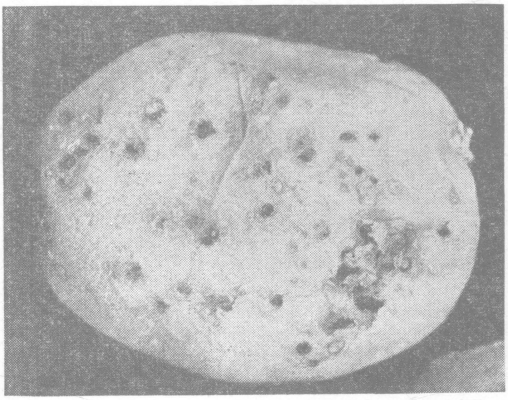


Fig. 43.—Millipede injury to potato.

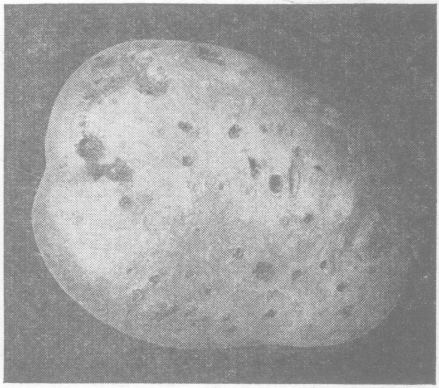


Fig. 44.—Wireworm injury to potato.

POTATO (Continued)

Insect or Disease	Description	Remedy or Prevention
Fusarium wilt (Stem end discoloration) (Fig. 45)	Plants usually stunted, light green in color; leaves rolled or wilted and plants die prematurely. Inside "bark" of stems discolored; sometimes brown spots in pith between the nodes in upper portion of stem. Stem end of tuber frequently sunken, and brown to black areas inside. Discoloration increases in storage	Most severe during dry, hot seasons Discard discolored tubers at planting time Use 3- to 5-year rotation In dry years, irrigate crop if possible
Yellow dwarf (Virus)	Plants dwarfed, yellowish-green, usually bushy. Upper leaflets turn yellow at the base and plant dies from tip downward. Brown flecks inside stem mostly at nodes in upper part of plant; tubers cracked, oddly shaped, and frequently brown flecked	Plant certified seed free from *Yellow dwarf* Transmitted by clover leafhopper Rogue diseased plants
Mosaic (Virus)	Leaves small, mottled with lighter and darker green areas. Leaves often curled or wrinkled	Plant certified seed Rogue diseased plants
Leaf roll (Virus)	Plants often dwarfed and stand stiffly erect Leaves roll upward toward midrib, are crisp and papery, crackling when pressed together Plants often stunted	Plant certified seed Rogue diseased plants

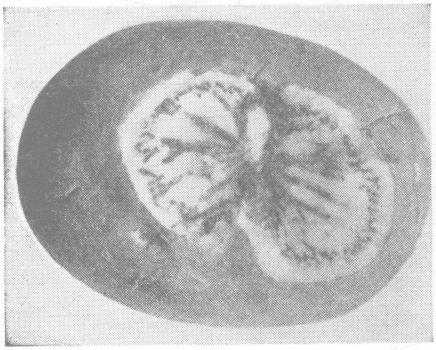


Fig. 45.—Fusarium wilt or stem end browning.

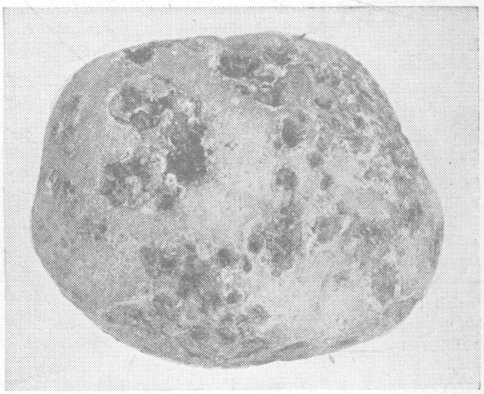
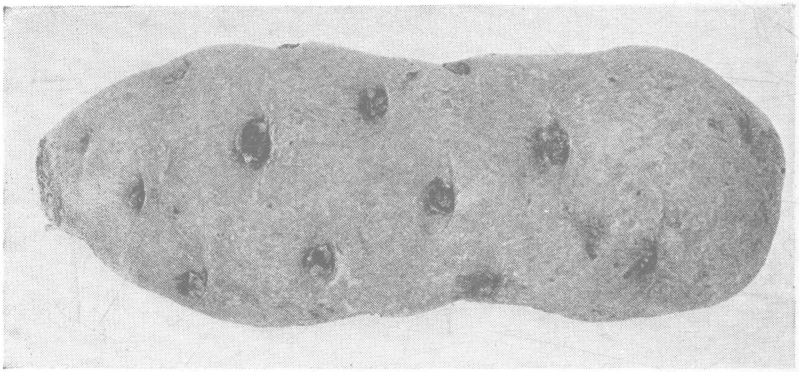


Fig. 46.—Common scab on potato.



(From N. Y. Agr. Exp. Sta.)

Fig. 47.—Spindle tuber (Virus).

Insect or Disease	Description	Remedy or Prevention
Common scab (Actinomyces) (Fig. 46)	Tubers with rough, corky, brown patches, often circular	Do not use scabby potatoes for seed Plant in new location in an *acid* soil if possible Try such scab-resistant varieties as Cayuga, Seneca, Ontario and Menominee
Spindle tuber (Virus) (Fig. 47)	Tubers elongated, cylindrical in shape, shallow eyes with prominent "eyebrows'.' Leaflets roll upward along midrib, have wavy margins, grow lopsided	Plant certified seed
Rhizoctonia (Black scurf)	Brown or blackish irregular bodies on surface of tubers. Best seen when wet Tops often stunted and with small aerial tubers. Young shoots with brownish cankers often killed and replaced by others. Brownish lesions on underground stems	Soak seed 1½ hours in a solution of corrosive sublimate 4 oz. in 30 gals. water just before planting; *or* Dip for 1 minute in a suspension of 2 lbs. yellow oxide of mercury in 30 gals. water
Storage dry rots	Sunken discolored areas usually starting at wound. Flesh discolored, dry and cheesy. May rot entire tuber. Sometimes rotted portion is wet and slimy with a foul odor	Avoid cutting or bruising tubers while digging. Store between 35 and 40 degrees F.
Bacterial ring rot	Yellowish-white crumb-like decay in region of vascular ring of potato tuber	Use certified seed Do *not* plant any with *ring rot* symptoms

PUMPKIN

Insect or Disease	Description	Remedy or Prevention
SQUASH VINE BORER	See Squash	See Squash
SQUASH BUG OR "STINK BUG"	See Squash	See Squash
Downy mildew	See Cucumber	See Cucumber
Wilt	See Cucumber	See Cucumber
Black rot	See Squash	See Squash

RADISH

APHIS	Small green plant lice that suck sap from underside of leaves	See Tomato aphis (page 45)
ROOT MAGGOT (Fig. 48)	Small white maggots that burrow into radish beneath ground, causing decay	No remedy after maggots appear To prevent: pour a solution of corrosive sublimate (bichloride of mercury), 1 oz. to 10 gals. water along the row, using 1 gal. to each 35 ft. of row while plants are small. Repeat in 1 week (see p. 59); *or* Protect young growing radishes with a light application of 5% chlordane dust applied to soil along the row
FLEA BEETLE (Fig. 32)	Small black or striped jumping beetles that eat holes in the leaves of young radishes	Spray or dust with rotenone (page 51); *or* Spray with DDT (see page 52)
White rust (Albugo)	Leaves with white blisters which become powdery upon bursting	Pick off and burn diseased leaves as they appear Rotate beds
Black root disease (Fig. 50)	Steel-gray to black areas surrounding secondary roots. Black areas in long type of radishes	Grow Red Globe type of radishes Rotate crops

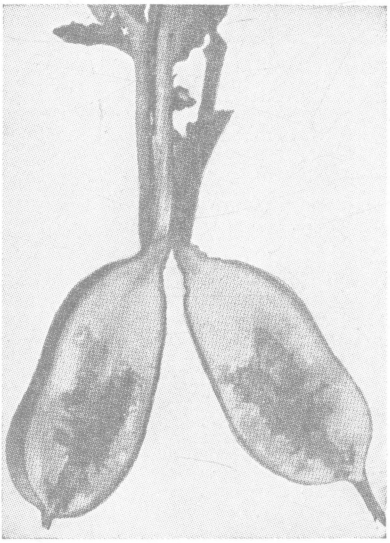


Fig. 48.—Root maggot injury of radish.

Fig. 49.—Foot or crown rot affecting the rhubarb plant.

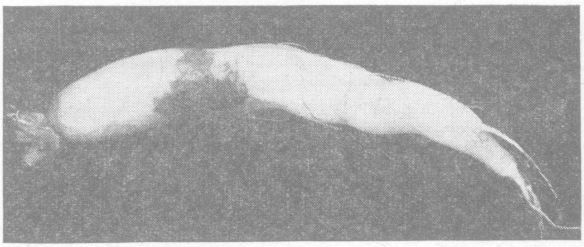


Fig. 50.—Black root disease of radish.

RHUBARB

Insect or Disease	Description	Remedy or Prevention
RHUBARB CURCULIO	Black snout beetles ½ in. long. Puncture stems, causing black spots	Hand pick beetles when observed Destroy docks in vicinity of rhubarb
Foot rot or Crown rot (Phytophthora) (Fig. 49)	Sunken brown spots on base of leaf-stalk. The spot enlarges rapidly and the leaf wilts. The rot progresses from stalk to stalk until the entire plant may be killed	Dig out and burn diseased plants, being careful not to scatter infected soil Disinfect soil with formaldehyde at the rate of 1 part to 49 parts of water Secure plants from healthy fields, or treat roots by dipping for ½ hour in either corrosive sublimate 1 oz. to 7½ gals. water, or formaldehyde 1 pint in 30 gals. Rinse in clean water Discard roots which are discolored inside
Leaf spot (Phyllosticta)	Irregular circular spots 1/10 to ½ inch in diameter, with white center surrounded by red band bordered by light green. Centers may crack and fall out, giving a shot-hole effect	Remove and burn old leaves and stalks in late fall after they have frozen Spray with bordeaux mixture 8-8-100 in spring when growth starts

ROSE

ROSE SLUG (Fig. 51)	Slimy green slugs that feed upon the surface of rose leaves, skeletonizing them	Dust plants with 0.75% rotenone; *or* Spray, or dust lightly* with DDT (see page 52) Apply from beneath
ROSE CHAFER (rose bugs)	Long-legged yellowish-brown beetles about ½ inch long that puncture young buds and leaves	Spray or dust lightly* with DDT (see page 52)
LEAFHOPPER	Small, greenish-white, active insects that suck the sap from underside of leaf. Cause leaves to have white speckled appearance	Spray or dust lightly* underside of foliage with DDT (see page 52). Repeat as necessary
JAPANESE BEETLE	Copper-colored beetle, ½ inch long with green head and small white spots along sides of abdomen	Spray lightly with 50% DDT wettable pwd., or chlordane pwd. at rate of 4 level teaspoons per gallon of water, *or* Dust lightly with 5% DDT, or chlordane dust

* Too heavy applications of DDT on roses may cause leaves to fall.

ROSE (Continued)

Insect or Disease	Description	Remedy or Prevention
LEAF ROLLER	Pale-green caterpillar with brown head. Rolls up and lives in fold of leaf	Spray or dust lightly with DDT as soon as observed (see page 52); *or* Dust with 0.75% rotenone
ANTS	No description needed	Ants on stems and buds do no direct damage to roses, but feed upon honey-dew secreted by amphis To control, see under Grass
APHIS OR PLANT LOUSE	Small, sluggish, green plant lice which mass upon the buds and stems, and suck the sap	Spray insects with nicotine sulfate 2 teaspoons to 1 gal. soapy water (see page 54); *or* Dust insects with nicotine dust (see page 54)
LEAF CUTTING BEE	Bee which cuts out circular pieces from leaf	No remedy known. Damage is not usually severe
Black spot (Diplocarpon) (Fig. 52)	Large, circular black spots with irregular margins on leaves	Dust thoroughly with sulfur-Fermate-lead arsenate (80-10-10) weekly; *or* Spray with wettable sulfur according to manufacturers' recommendations Begin application before disease appears; repeat at weekly intervals
Brown canker (Diaporthe)	Small reddish-purple spots on stems, petioles, leaves or petals. The stem cankers later turn white, enlarge the following spring into oval, light cinnamon-colored areas studded with small, black, protruding fruiting bodies Stems sometimes girdled with cankers	Prune plants heavily in spring, cutting out all cankers. Summer pruning is necessary if cankers develop Apply dormant lime-sulfur spray (1 lb. dry lime-sulfur to 3½ gals. water) before growth starts. After growth starts dust weekly with sulfur-Fermate-lead arsenate dust

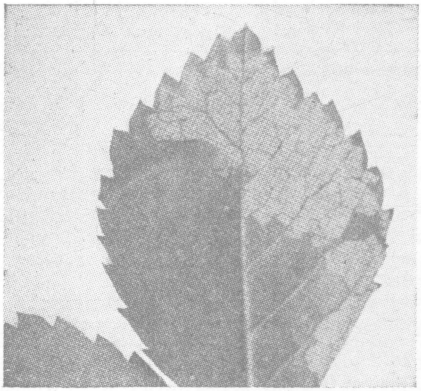


Fig. 51.—Rose slug.
(From Can. Dept. Agr.)

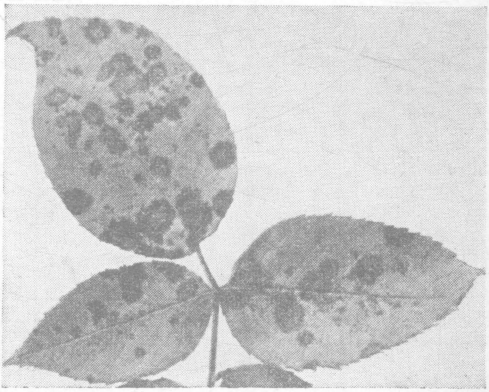


Fig. 52.—Black spot lesions.

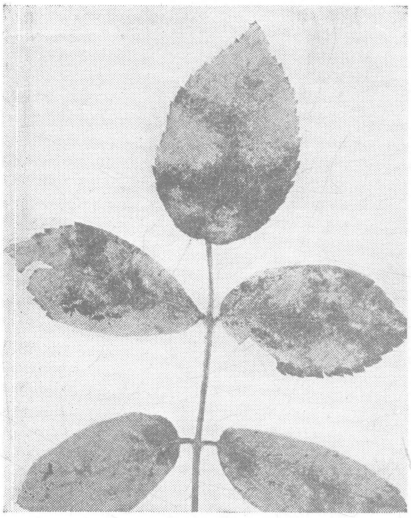


Fig. 53.—Powdery mildew on rose.

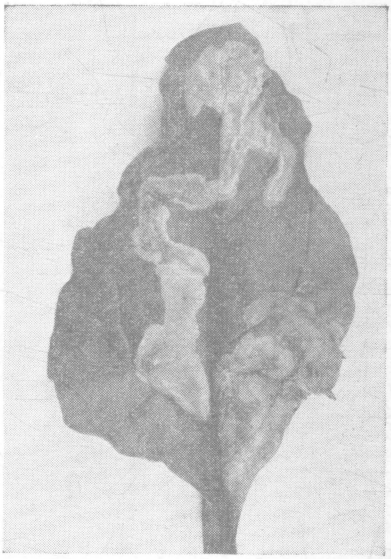


Fig. 54.—Work of leaf-miner on spinach.

ROSE (Continued)

Insect or Disease	Description	Remedy or Prevention
Stem canker or Graft canker (Coniothyrium)	Small, pale yellow or reddish spots which increase in size, later turning brown, occur on bark usually near ground. The cankered wood dries, bark cracks, and small black fruiting bodies dot the cankered area. Infection enters through grafting wounds, cut stub of canes, or other wounds	Use measures outlined under *Brown canker* Use *Rosa manetti* understock and clean scions In pruning cut back to nodes, do not leave stubs
Powdery mildew (Fig. 53)	Young leaves covered with white powdery growth, often dwarfed and deformed	Same as for *Black spot*
Crown gall (Bacterial)	Infected plants do not flower well. Galls form at the crown or at the point of grafting. Galls on aerial stems may be found in greenhouse	Remove and burn infected plants Disinfect soil formerly around plants by drenching with 1 oz. corrosive sublimate in 7½ gals. water, or 1 pint formaldehyde in 7 gals. water Do not replant before 2 weeks

SALSIFY

White rust (Albugo)	Small white blisters appear on leaves. Become powdery when broken open	Remove and burn diseased leaves If disease is prevalent, spray with 8-8-100 bordeaux mixture 3 or 4 times at 10-day intervals, starting before it usually appears

SNAPDRAGON

Insect or Disease	Description	Remedy or Prevention
Rust (Puccinia)	Reddish-brown rust pustules generally appear on lower surface of the leaves, although other parts of the plant are susceptible May cause rapid wilting and death	Plant rust-resistant varieties Water surface of soil in morning rather than sprinkle Start plants from seed Plant where air circulates freely and space well Dust with sulfur-Fermate (90-10) weekly until bloom

SPINACH

APHIS	Greenish - yellow plant lice that suck juices of leaves and kill plants	Use either nicotine or pyrethrum spray (see pages 54-58) ; *or* Dust with nicotine (see page 54)
LEAF-MINER (Fig. 54)	Maggots that mine in the leaves making "blister-like" mines and injuring them for greens	No safe insecticide control known Keep lamb's quarters from growing near spinach
CABBAGE LOOPER	Looping green measuring worms that devour leaves	Dust with rotenone as recommended on page 51, or, undiluted calcium arsenate applied lightly Do *not* apply arsenicals to spinach ready to cut
Downy mildew (Peronospora)	Pale yellow spots with indefinite margins on upper surface of oldest leaves. On lower leaf-surface spots are covered with a violet-gray mold. Later these spots die and when severe, entire plant is killed	Plant spinach on fertile well drained soil Do not crowd plants, cultivate freely, and keep down weeds If overhead irrigation is used water on bright days if possible

SQUASH

CUCUMBER BEETLE (*striped*)	See Cucumber	See Cucumber
SQUASH BUG OR VINE BORER (See cover page, also Fig. 55)	White grub-like caterpillar which burrows within the vine, causing it to wilt and die beyond point of attack	Locate point of attack by presence of yellow excrement on outside of vine. Cut out borer at this point and mound loose soil over vine here Burn vines as soon as crop is harvested To prevent: dust vines weekly through July with 1% rotenone, or with 3% aerosol grade DDT (see warning page 52)
SQUASH BUG OR "STINK BUG" (Fig. 56)	Large brown plant bugs that suck sap from leaves, causing them to wilt about time vines begin to run. Bugs not observed doing the injury may be found under clods near plant in early morning	Remove the eggs from the undersides of leaves in June When injury is first noticed, trap bugs under pieces of burlap or boards placed on the ground near the plants For larger areas, spray or dust with aerosol grade DDT, or with methoxychlor (pages 53 and 60)

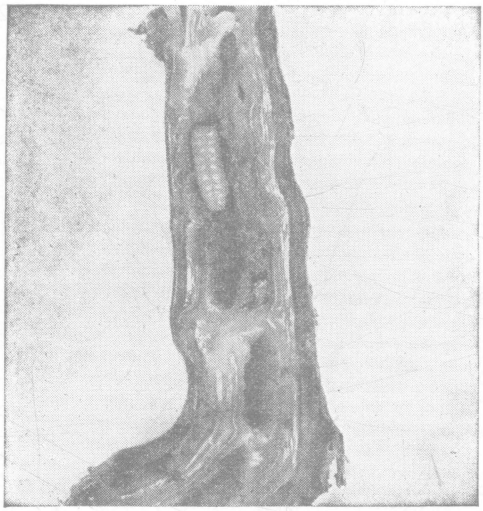


Fig. 55.—Squash vine borer.

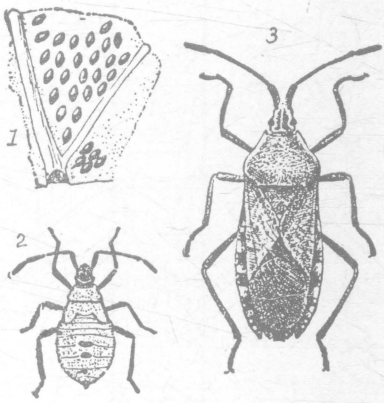


Fig. 56.—Squash bugs.

1. Squash bug eggs.
2. Young squash bug.
3. Adult squash bug.

Insect or Disease	Description	Remedy or Prevention
MELON APHIS	Small slate or yellowish colored lice on lower surface of leaves and growing tips	See Cucumber Use of aerosol grade DDT seems to keep them under control
PICKLE WORM	See Cucumber	See Cucumber
Black rot (Mycosphaerella)	Leaves with gray to brown dead spots of varying size dotted with fungous fruiting bodies. Fruit spots at first water-soaked or gray, then turn black. May spot fruit or cover entire area. Stem may be girdled at a node by a water-soaked or dark canker, killing vine beyond girdle	See Cucumber anthracnose
STRAWBERRY		
CROWN BORER	Small white grub hollowing out crown	Plow up beds after crop is harvested. Rake up and burn infested plants. Set new plants some distance from old bed
ROOT WORMS (Fig. 57) (Strawberry leaf beetle)	Small beetles eat numerous holes in leaves in late spring and early fall. Larvae eat roots during midsummer	In May when beetles are first observed dust with cryolite (see page 59) Rotate strawberry beds Plow down infested beds in July
SPITTLE BUG	Straw-colored and robust plant bugs that secrete and live in masses of "spittle." Bugs suck sap from plants	Apply benzene hexachloride 5% dust to strike the masses of spittle in May. Bugs mix this with secretion and are killed (see page 59), *or* Spray with 1½ lbs. benzene hexachloride (6% gamma isomer) in 50 gals. water Do *not* apply within one week of harvest

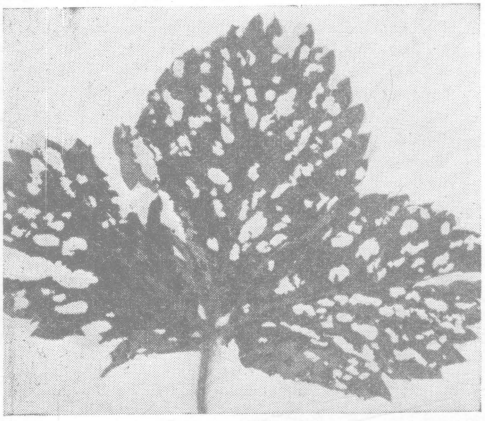


Fig. 57.—Damage from adult strawberry root worm.

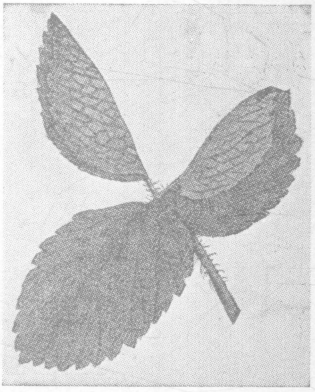


Fig. 58.—Strawberry leaf roller (caterpillar inside folded leaf).

Insect or Disease	Description	Remedy or Prevention
LEAF ROLLER (Fig. 58)	Leaflets folded and webbed together with small green larva feeding within	To prevent: spray with 1 lb. 50% wettable DDT powder in 50 gals. water at 15-day intervals beginning late in August to destroy hibernating larvae If injury is under way when berries are ripening, spray with ½ gal. summer oil and ⅓ pint nicotine sulfate in 50 gals. water
MILLIPEDES	Elongated, slender small worms that bury themselves in ripening berries in contact with the soil	Dust soil lightly with 5% chlordane so that millipedes must crawl over the dusted soil to reach the berries
PLANT BUGS *(Myodochus serripes)*	Narrow,long-legged,black and amber colored bugs that puncture ripening berries, causing them to be soft and moldy	No satisfactory control method has been devised DDT is worthy of trial. Avoid applying too freely to ripening fruits
WHITE GRUBS (See Fig. 1)	Fleshy white grubs that attack roots of new plants	Thoroughly mix 1 part by weight of lead arsenate with 20 parts of dry soil and place a handful in hole where each new plant is set. This protects against injury for life of the plant
Leaf spot (Mycosphaerella)	Small red or purple circular spots, later with gray centers and red or purple borders	Grow more resistant varieties like Premier and Fairfax Set out healthy plants in fertile well drained soil Spray with 4-6-100 bordeaux every 10 days until the disease is controlled
Scorch (Diplocarpon)	Irregular purplish spots; leaf margin has scorched appearance	Same as for *Leaf spot*
Gray mold (Botrytis)	Berries rot, turn brown are covered with fluffy, dusty gray fungous growth	Is favored by wet weather and difficult to control Set plants in well drained soil Keep patch free from weeds Mulching tends to reduce rot

STRAWBERRY (Continued)

Insect or Disease	Description	Remedy or Prevention
Black root rot (Unknown)	Leaves yellowish-green, wilt and plants frequently die Roots black, dead, outer parts drop off, leaving the central core in long strings	Use good cultural practices Set healthy plants in early spring in fertile well drained soil. Sidedress with sulfate of ammonia or nitrate of soda when plants are well established. If spring is dry irrigation is helpful Mulch plants in fall before severe freezing
Red stele (Root rot)	Plants wilt and die usually in spring, or late fall during cool weather. The cores or roots of diseased plants are red in color. Roots are devoid of fibrous, hairy laterals giving a rat-tailed appearance	Set only disease-free plants on well-drained, fertile soil, uncontaminated by the red stele fungus. Such varieties are: Sparkle, Temple, and Pathfinder Since the fungus can live for several years in soil, practice crop rotation with 4 years intervening between strawberry crops

SWEET PEA

Anthracnose (Glomerella)	White areas appear on leaves, causing them to fall about blossoming time. Tips of growing shoots may wilt and dry up. Entire flower stalk frequently killed Infection carried in seed	Buy seed from reliable dealer and treat seed before planting as for damping-off (see page 62) Plant seed in soil freshly treated with 3 oz. formaldehyde dust per foot of row worked into soil 6 inches deep and 12 inches wide
Black root rot (Thielavia)	Plants yellow, dwarfed, and easily pulled from soil as small roots are rotted off Large roots and base of stem black	Control measures as outlined for *Anthracnose*
Streak (Bacterial)	Reddish-brown to dark-brown streaks and spots on stems near ground; streaks move upward in stem into leaves and flowers, spotting and killing them prematurely	Control measures as outlined for *Anthracnose*

SWEET POTATO

TORTOISE-BEETLE or "GOLD-BUG"	Small, oval, bright colored beetles, flattened in appearance. Eat holes in the leaves soon after plants are set out Larvae are flat with side spines at edges of body; feed under leaves	Spray or dust plants with DDT (see page 52) *or* Dust plants with 0.75% rotenone
FLEA BEETLES	Very small brown, or black beetles that "shred" the leaves	Spray, or dust with DDT (see page 52)
Pox (Actinomyces sp.)	Yellowing and stunting of infected plants. Causes brownish, sunken, and somewhat cracked spots on potatoes	Use only clean, sound seed Rotate crops In badly infected fields applications of sulfur have given satisfactory control. Sulfur should be applied with caution since it may cause injury to succeeding crops

SWEET POTATO (Continued)

Insect or Disease	Description	Remedy or Prevention
Stem rot (Fusarium spp.)	Diseased plants become yellowish in color and lower leaves drop off. Base of stem becomes dark and on splitting a brown or black layer is found just under the bark	Seed selection Care in seedbed preparation Use resistant varieties such as: the *Spanish* group namely: Dahomey, Red Brazil, Southern Queen, Yellow Strassburg, Key West, Triumph, and White Yan. The *Jersey* group is most susceptible to the disease

SWISS CHARD

Leaf spot (Cercospora)	Many small circular to irregular dead spots with white to gray centers	Cut off the older infected leaves and stimulate new growth by the application of nitrate of soda or sulfate of ammonia to soil Use 3-year crop rotation omitting beets therefrom

TOMATO

CUTWORM (Fig. 59)	Fleshy caterpillars which cut off the plants at surface of ground. Hide in the soil during the day One species bores into the green tomato fruit	Prevention: Wrap a 4-inch collar of paper around plant Trap under boards when worms are noticed; *or* Scatter poisoned bran mash during evening (see page 60)
FLEA BEETLE (Fig. 31)	Small black or striped jumping beetles, which eat small holes in the leaves of newly set plants	Spray or dust young plants lightly with rotenone (see page 51); *or* Dust lightly with cryolite (see page 59) DDT should not be applied to young tomato plants
PINWORM	Very small bluish caterpillars that mine leaves, tie them together, and tunnel into fruits, causing decay (Present only in vicinity of Cleveland and Columbus)	Dust plants with a mixture of 2 parts cryolite and 1 part talc; *or* Dust lightly with 2% DDT as needed, *or* Spray with 8 oz. cryolite; *or* 1½ oz. DDT (5 level tablespoons of 50% strength) in 10 gals. water (see page 52). One thorough application will prevent damage for 3 or 4 weeks
APHIS (See Potato, p. 33)	Pink and green plant lice that suck the sap from blossoms, stems and underside of leaves, causing plants to wilt	Spray insects with nicotine sulfate 2 teaspoons to 1 gal. water containing a little dissolved soap. Drive spray against underside of leaves
STALK BORER (Fig. 28)	Striped caterpillar that bores within stalks, killing plant (see Corn)	No remedy except to replant (see under Corn)
HORNWORMS	Large, green worms with a projection or horn on the back. Feed on the leaves	Hand-pick worms on small patch Apply a dust of 14 lbs. fixed copper, 50 lbs. calcium or lead arsenate, 36 lbs. talc on large plantings. *Wash* fruits well before using, *or* Apply a commercially prepared cryolite dust mixture. See page 59
BLISTER BEETLES (See Fig. 4)	Large, elongated, striped or gray beetles that strip the foliage from the vine	Spray, or dust with aerosol grade of DDT, or with cryolite (see pages 52, 59)

TOMATO (Continued)

Insect or Disease	Description	Remedy or Prevention
Russet mite (Lakeshore counties)	Tiny mites that crawl over leaves and fruit causing first the basal leaves and later younger leaves to turn yellow Causes the fruits to take on a "russeted" appearance	Buy plants from uncontaminated source Greenhouse infestation controlled by use of HETP, or parathion aerosol bombs Outdoor infestation best controlled with HETP, or parathion spray
CORN EARWORM Also called "fruit worm" (Fig. 60)	Green worms which bore into earliest maturing tomato fruits and eat out cavities	Collect and destroy infested tomatoes as soon as discovered—July in field plantings, October in greenhouses A bait made by mixing 1 part of cryolite with 10 parts of cornmeal gives fair control when scattered over plants. Three or four applications are needed *or* Dust lightly with a 50% cryolite-talc mixture
Bacterial spot	Angular lesions with dark glistening centers on leaves. Minute black raised spots surrounded by water-soaked zone on fruit	Plant clean seed or treat seed before planting (see page 62) Rotate crops Clean up and burn old tomato tops or turn under deeply after harvest
Early blight (Alternaria)	Dark brown or black circular spots with concentric rings in leaves	Spray with fixed copper 4-100; Dithane Z-78, Parzate, or Zerlate 2-100; or use corresponding dusts—fixed copper 14-86, or other three materials in an 8-92 formula

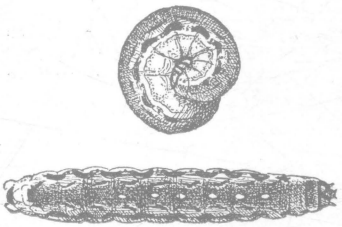


Fig. 59.—Variegated cutworm.

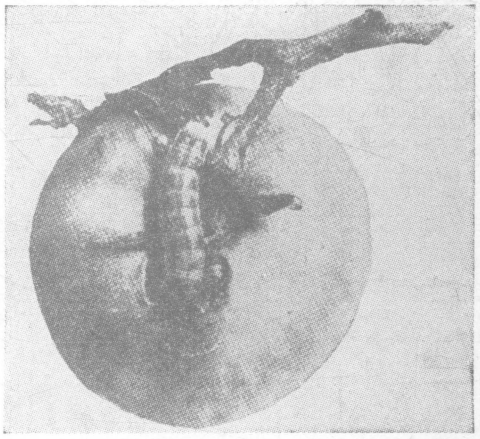


Fig. 60.—The corn earworm also attacks tomatoes.

TOMATO (Continued)

Insect or Disease	Description	Remedy or Prevention
Late blight (Phytophthora infestans)	On the leaves it forms large water-soaked dark-colored spots. On the underside of the leaf occasionally a white moldy growth may be seen. On the fruit the disease causes large, dark brown-colored spots of varying size; somewhat rough in appearance	Begin spraying at weekly intervals when disease is reported in your area Use fixed copper 4-100; or Dithane Z-78 or Parzate 2-100. Bordeaux mixture 8-8-100 may be used during latter part of season Dusting must be carefully done with plenty of material to get satisfactory control
Septoria leaf spot (Fig. 61)	Dark brown circular spots with minute black dots. Whole leaves die, shrivel, and hang down or are blown off	Use treatments recommended for *Late blight* control Grow partially tolerant varieties such as Marglobe and Break O'Day Do not work in wet plants after disease appears Rotate crops, remove and burn all tomato refuse

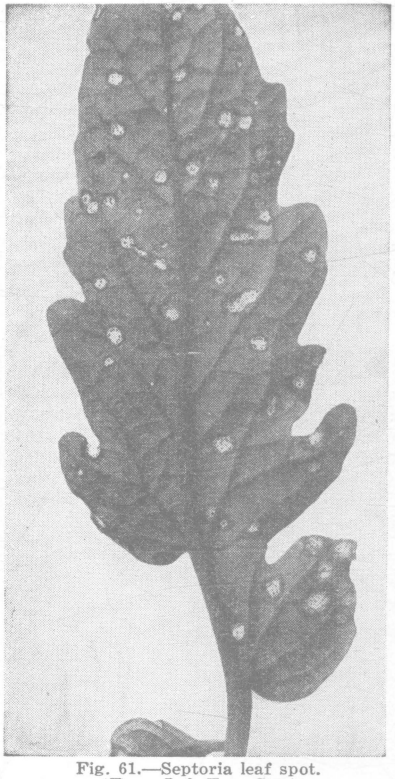


Fig. 61.—Septoria leaf spot. (From Ind. Exp. Sta.)

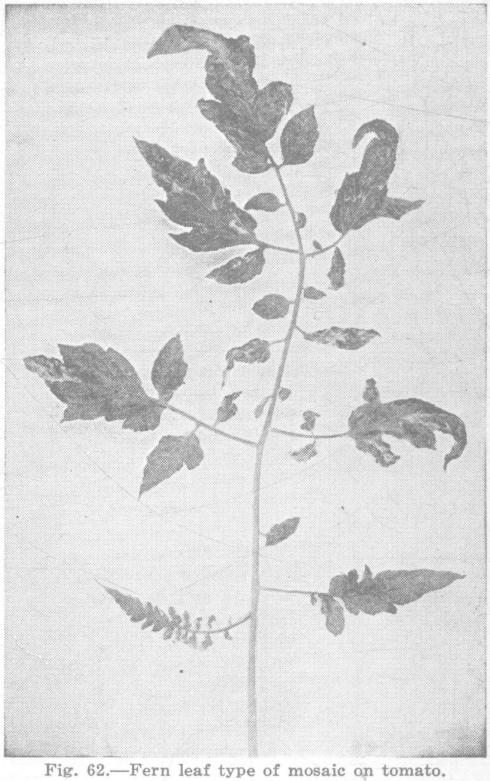


Fig. 62.—Fern leaf type of mosaic on tomato.

TOMATO (Continued)

Insect or Disease	Description	Remedy or Prevention
Blossom-end rot	Water-soaked area on blossom-end of fruit, later turns brown or black and shrivels. Caused by withdrawal of water from fruit during periods of high evaporation	Set plants in well drained soil high in organic matter Cultivate freely until third cluster blooms Mulch with clover chaff or sample grade alfalfa or soybean hay Water very freely after mulching If early tomatoes are not desired grow plants on the ground
Streak (Virus)	Dead, brown areas in upper leaves; brown streaks on petioles, and dark streaks on stem. Plants are stunted and may die	Caused by the mixing of two viruses in the tomato plant; most commonly a tobacco *virus* and a potato *virus* Prevent *mosaic* in plants (See *Mosaic*)
Fusarium wilt	Leaves roll upward and wilt during the middle of the day. Lower leaves turn yellow and drop off. This yellowing progresses upward on the stem until the entire plant is killed. Inner "bark" dark when stem is cut across near the ground	Use a 5-year rotation Grow resistant varieties like Marglobe, Break O'Day, Pritchard, Rutgers, or Early Baltimore. These varieties are not always resistant in the greenhouse and steam sterilization should be used
Mosaic (Virus) (Fig. 62)	Leaves mottled with lighter and darker green areas. Distorted, often narrow and needle-like	Destroy diseased plants if few in number Keep down insects and fertilize heavily Eradicate ground cherry, horse-nettle, Jimson-weed, nightshade, bittersweet, matrimony-vine, and wild cucumber Avoid use of tobacco while working with young plants
Anthracnose	Sunken, circular spots on fruits, darker than adjacent areas. Spots ⅛ to ½ inch in diameter with concentric rings	Spray with Zerlate 2-100, or dust 8-92 may be used. Make first application when fruits in first cluster are half grown. Follow with four more at 10-day intervals. Coppers *ineffective* in controlling this disease, but should be used in alternate applications with Zerlate if *Late blight*, or *Septoria* threatens
Bacterial canker	Often confused with Fusarium wilt. Pith or inner part of stem shows decay. On fruits raised white spot appears, later center of spot becomes brown but white halo persists	Use disease-free seed and plants Use new or sterilized soil each year Spraying or dusting not effective

TULIP

Insect or Disease	Description	Remedy or Prevention
Botrytis blight or Fire	Black, pin head size sclerotial bodies on brown bulb husks. Yellow to brown lesions on the bulb. Small, yellowish water-soaked spots on leaves; these may enlarge, turn gray, become covered with a gray mold during wet weather. White to light brown spots on some blossoms, others may blight before or after emergence	Remove outer husks, sort bulbs carefully and discard diseased ones before planting. Remove infected plants soon after they come up Remove and destroy all plant debris after blooming. If bulbs are to remain in the soil, cut yellowed tops below ground and burn them If severe, plant new bulbs in different location

TURNIP

APHIS	Small, green, sucking plant lice that mass on the undersides of the leaves	Leaves lie too close to the ground to kill lice with sprays When lice appear, dust plants lightly with high gamma benzene hexachloride (see page 59) as a *trial* method
ROOT MAGGOT (Fig. 48)	Very small, white maggots that burrow into root, causing decay	No direct remedy Rotate turnip beds Destroy crop remnants in autumn
FLEA BEETLE	See Radish	Spray or dust with rotenone, with DDT, or with cryolite (pages 51, 52, and 59)

WATERMELON

See Melon	See Melon	See Melon

Spraying and Dusting

●

COMPARISON OF THE TWO METHODS

Protecting the home garden from insect and disease attacks does not require expensive equipment. In most cases one has the choice of spraying or dusting as a method to use. Each method has its merits and the choice will depend upon the preference of the individual and the equipment available. Some advantages of each method are:

SPRAYING—Material adheres better to foliage than when dusted and fewer applications are necessary to protect crops.
Can be done under weather conditions, such as light wind and dry foliage which may make dusting impracticable. Less materials are wasted in spraying than in dusting.

DUSTING — Less time is required for applying the material than spraying.
Less labor is required for dusting, and there is less inconvenience in handling the hand duster than the hand sprayer.
Less danger of burning tender foliage than spraying.
More efficient in killing aphids that attack leaves of low growing crops where it is impossible to force liquid spray against the bodies of the insects.

Whether spraying, dusting, or a combination of both methods is followed, good equipment should be provided, and thoroughness of application is essential if control is to be secured.

SPRAYING AND DUSTING EQUIPMENT

Sprayers:

For treating a few small plants an atomizer type of hand sprayer is useful. One should not try to use it beyond its capacity. For the average home garden the knapsack sprayer, compressed air hand sprayer, bucket pump, and barrel pump are the common types used. The area to be covered, frequency of spraying needed, labor supply available, and simplicity of construction of the sprayer should guide the purchaser in making his selection.

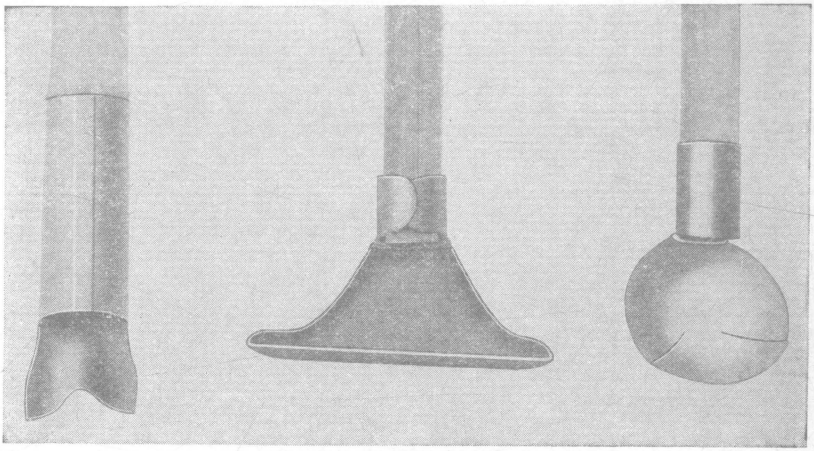


Fig. 63.—Three types of deflector attachments for fitting to delivery tube of duster.

The nozzle is a very important part of the sprayer. This should break up the liquid into a fine mist and also deliver the proper volume. On types larger than the hand atomizer a small vermorel or disk nozzle should be used. Equip the pump with six or seven feet of hose and a 4-foot extension rod furnished with a 45 degree L or angle pipe to connect with the nozzle. The nozzle may be of the angle type which, when fitted to the L, delivers the spray at right angles to the pipe and enables one to cover the underside of the leaves (see Fig. 65). This is absolutely necessary in spraying for Mexican bean beetle or for aphis.

Dusters:

Good hand dusters, which deliver the material in a dust form, can be purchased for amounts ranging from $2 to $25, depending on the capacity desired. These are of the plunger, fan, and bellow types. In making the selection one should choose a duster that will be well balanced on the operator's body and

Fig. 64.—Bellows type duster suitable for either hill or row crops.

Fig. 65.—A convenient sprayer for the home garden.

easy to operate. This will relieve fatigue and its more frequent use. It should be as free as possible from complicated mechanism and should be adjustable to width of row treated. The purchaser should see that the delivery tube is fitted with a metal guide or deflector to force the dust against the undersides of leaves when necessary (Fig. 63). The better dusters are fitted with cut-off to regulate the amount of dust that flows into the delivery tube. Even distribution of the dust is an essential requirement.

Materials to Use for Sprays and Dusts

The spraying or dusting materials that are almost certain to be needed by the home gardner are: (a) *rotenone bearing material* for Mexican bean beetles, cabbage worms and cucumber beetles, (b) *DDT* for leafhoppers, potato and cabbage insects, European corn borer and for pests on most garden crops, (c) *nicotine sulfate* solution or *nicotine dust* for plant lice, and (d) *bordeaux mixture, fixed copper, carbamates, wettable sulfur,* or *sulfur dust* for plant diseases. In a few cases other materials are preferred for specific insects, diseases or plants. These are cited under the disease or insect with proper recommendations. (See pages 56, 57, 59 and 60 for new fungicides and insecticides).

Rotenone Sprays and Dusts

Rotenone is the principal insecticidal constituent in derris, timbo, and cube root. These carry form 4 to 5% of rotenone. It is very toxic to some insects, being both a contact and stomach poison. Rotenone has been quite dependable as a spray and dust against the Mexican bean beetle, currant worm, cucumber beetle, flea beetle, and the imported cabbage worm. It leaves no poisonous resi-

due, does not injure plants, and is safe to use on maturing cabbage, and cauliflower. Its action is slower than most contact insecticides and it retains some of its toxicity for several days.

Rotenone dust should be applied with an inert carrier, such as finely ground tobacco, fine dusting gypsum, sulfur, talc, or clay, but *never with lime, copper-lime dust,* or *bordeaux.* While sulfur is an excellent carrier for rotenone on *beans,* it should not be used on cucumbers and melons. Rotenone is more expensive than arsenicals, but being very toxic is adapted to special uses. Dusts carrying 0.75 per cent of rotenone are recommended and on row crops are applied at the rate of 20 to 30 pounds per acre or about 3 ounces per 100 feet of row. They can be purchased ready mixed or can be made at home. A satisfactory dust for use on beans or cabbage is prepared by thoroughly mixing 3 pounds of powdered derris root containing 4 per cent of rotenone and 17 pounds of one of the above carriers. This amount will treat about ¾ acre. For bean beetle spraying, use 2 ounces of the ground root (or 13 level tablespoons) in 3 gallons, or 2½ pounds in 50 gallons of water. The ground root should be mixed first with a small quantity of water to make a thin paste, then added to the spray. If ground derris, timbo, or cube root is not available, 15 pounds of 0.75 per cent rotenone dust can be used in 50 gallons of water. However this results in so much solid material in the spray that it is likely to cause difficulty in applying with low pressure. For some plants a sticker is desirable but such is not necessary on beans. Spray or dust applications must be directed against the underside of bean leaves.

DDT

DDT is an abbreviation of a synthetic organic insecticide known to chemists as: Dichloro-diphenyl-trichloroethane. It has wide insecticidal usage outside of the agricultural field, being very effective against mosquitoes, flies, lice, bedbugs, fleas, and most household insects. Its performance against many of our vegetable and flower insects is very satisfactory. For controlling leafhoppers and thrips it is almost phenomenal. It performs as well, or better than rotenone against most caterpillars and beetles, with the exception of the Mexican bean beetle; affecting first the nervous system, followed by paralysis and slow death. It does not control the Mexican bean beetle satisfactorily. On cucumbers, melons, and some varieties of squash the use of the *technical* grade of DDT is attended with some risk of injury by stunting the plants and reducing the yield. It should not be used on these plants where substitute insecticides are satisfactory. Some varieties of squash and melon are very susceptible to DDT injury. However a special grade of DDT, known as the "aerosol" grade, has caused no injury to cucumbers, squash, or melons when applied in a full schedule.

The margin of safety between the insecticidal strength and the concentration causing plant injury on tomatoes is so narrow that even a 3% DDT dust sometimes injures young tomato plants. The 2% dust, or aerosol grade is preferred on tomatoes.

DDT fails to control most species of plant lice (aphids), and its use on some plants may promote injury by red spider, for which it is not effective although it kills the natural enemies of red spider. DDT appears to be an ideal insecticide for use on potatoes in Ohio where it controls all of the chief insect pests. When applied to the underside of bean foliage it controls leafhoppers without injuring the plant. It can be combined with all of the fungicides used in garden sprays, or dusts.

Fig. 66.—Small power duster on beans. (Courtesy Root Manf. Co.)

How Used.—When used on plants, DDT is applied as a dust carrying either 3 or 5 per cent ACTUAL DDT, or as a wettable powder to be held in suspension in water and applied as a liquid spray. The wettable powder for liquid spraying usually will carry either 50 per cent, or 25 per cent of technical grade DDT processed, finely ground and mixed with an inert carrier such as talc. For most insects it is applied at the rate of 1 pound of ACTUAL DDT per 100 gallons of water. This is equivalent to 1 oz. (3½ level tablespoons) of 50 per cent material in 3 gallons of water. For the 25 per cent material, twice as much should be used. Use the heavier strength shown on page 61 for insects difficult to control.

For potatoes, which receive a schedule of many sprays, only ½ to ¾ pound of ACTUAL DDT per 100 gallons is recommended. It is not necessary to include a sticker or spreader, as DDT, when once dry, is difficult to wash off. Frequent applications are necessary to keep the new growth covered. For potatoes, DDT can be combined with 8-8-100 bordeaux mixture, or, when necessary, with any of the fungicides used in garden sprays. This is expressed as 8-8-1-100, the figure 1 meaning that 1 lb. of 50% DDT mixture is added to 8-8-100 bordeaux.

For general garden use the dust form is more adaptable than the spray. Dusts are more easily directed against the underside of foliage for leafhopper control and more convenient where weekly, or 10-day applications are made.

Commercial potato dusts now carry mixtures of DDT and fixed copper for insects and blights. Only light applications of dust are necessary, but it is important to keep the new growth covered before it becomes damaged.

DDT, when held in solution or emulsion in water by means of an oil should *never be applied to plants.* This form of the material is meant for barn, dairy and household use. If non-oil solutions, or emulsions are used on vegetation, the manufacturers' directions should be followed.

Since applications of DDT to flowers and shrubs promote injury by red spider mites, it should *not* be used on ornamentals subject to red spider attack.

Nicotine Sprays

Concentrated tobacco solution for spraying plant lice is sold under several trade names. These carry nicotine as a poison. The nicotine is combined with sulfuric acid and known commercially as Nicotine Sulfate. This can be diluted to the proper strength with accuracy, and is very toxic to plant lice at a strength of 1 part to 500 of water, or 1½ to 2 teaspoons to 1 gallon of water. This contains approximately .07 per cent of nicotine.

Home-made nicotine spray can be made by soaking waste or damaged tobacco in water, with occasional stirrings, for a period of 24 hours, then straining. This extracts from 70 to 80 per cent of the nicotine. It should not be made up until ready for use. To prepare 50 gallons of spray would require soaking 9 to 14 pounds of leaves, 40 to 50 pounds of tobacco sweepings, or 55 to 70 pounds of stems. The amount of tobacco needed in making a home-made spray is too great and the nicotine content of the resulting solution is too uncertain to make the method economical or dependable.

Black leaf 40 is the commercial nicotine sulfate most widely sold in Ohio, and contains 40 per cent nicotine. This spray kills only when it comes in contact with the bodies of the insects, hence must be directed against the underside of the leaves. It may be combined with stomach poisons for controlling both aphis and chewing insects. It can also be used with bordeaux mixture. When nicotine sulfate is used, soap should be added at the rate of 1 cubic inch to each gallon of water, or 2 to 3 pounds to 50 gallons. Dissolve the soap in a little hot water before adding to the spray. In a nicotine-bordeaux combination spray, omit the soap.

Nicotine Dusts

The presence of gaseous nicotine distributed through a finely divided dust offers an opportunity to apply this insecticide to plants in the form of "nicotine dust." This mixture is serviceable for killing plant lice and other soft-bodied insects, provided the material carries enough nicotine and the dust can be brought in contact with their bodies. Results from the factory-made product have been very variable, due apparently to the deterioration of the stored product.

Nicotine dusts can be prepared at home by mixing nicotine sulfate with hydrated lime. To make a small quantity, secure a half gallon or a gallon can provided with a tight fitting lid. Fill the can not over half full of lime and place in it several small stones for a breaker. Pour over the lime the required amount of nicotine sulfate and shake or rotate the can for five minutes. This mixes the nicotine sulfate evenly throughout the lime and results in a dust from which free nicotine is given off rapidly. After standing a few minutes the dust is ready to use. It is very toxic to insects when sufficient nicotine sulfate is used. A dust carrying 3 per cent of actual nicotine is recommended as the strength to use for a satisfactory kill of plant lice under most conditions.

The following quantities of 40 per cent nicotine sulfate and lime should be used for the concentration of nicotine desired in a home-made dust:

Strength of Nicotine	Amount of Nicotine sulfate to add to *1 qt. of lime*	or	*50 lbs. of lime*
To make 2 per cent	use ¾ oz.		2½ lbs. or 2 pints
To make 3 per cent	use 1 oz.		3¾ lbs. or 3 pints
To make 4 per cent	use 1½ oz.		5 lbs. or 4 pints

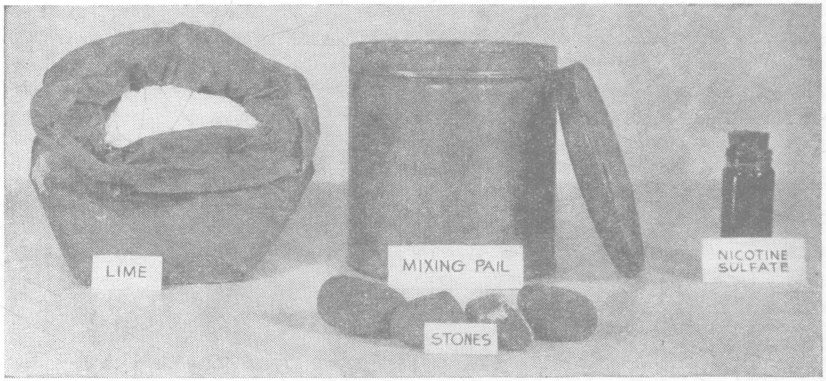


Fig. 67.—Equipment and material used in mixing home-made nicotine dust.

Sulfur Dusts and Sprays

Sulfur, whether in the form of a dust or spray, is seldom used as a fungicide on vegetables. Its use on fruits and ornamentals is much more general. It has been found to increase celery yields when used with the fixed coppers for the control of leaf blights. Previous to the introduction of DDT as an insecticide, sulfur was used with rotenone to aid in the control of leafhoppers on beans, and is still used to control red spider. It is compatible with such insecticidal materials as the arsenicals, DDT, rotenone and nicotine sulfate. Since it tends to pack and become unmanageable when used alone, it is usually conditioned with some other material, such as lime, bentonite or talc.

Sulfur, to be used in dust formulas, is usually ground finely enough so that at least 90 per cent of it will pass through a 300-mesh screen. When it is to be used in spray formulas, on fruits or otherwise, it should be even more finely divided (micro-fine) if it is to afford maximum control. Wettable sulfurs, as well as flotation and other forms of paste are in common use for sprays.

Bordeaux Mixture and the Fixed Coppers

Bordeaux mixture was the most commonly used fungicide for the control of vegetable diseases for many years. It is still one of the most effective. However, because of the difficulty usually experienced by the small gardener in obtaining small quantities of freshly hydrated lime, and the fact that Bordeaux is somewhat injurious to many vegetables, especially when the plants are small, it is gradually being replaced by the fixed coppers, and more recently by various organic fungicides. Bordeaux mixture is used in different strengths for different purposes. These strengths are indicated by such formulas as: 4-6-100, 8-8-100, etc. The first figure represents the number of pounds of cop-

per sulfate (bluestone) used, the second indicates the number of pounds of good hydrated lime, and the third—the number of gallons of water.

When bordeaux mixture is prepared in small quantities, as it frequently is for the home garden, the necessary amount of copper sulfate should be dissolved in part of the water, the hydrated lime in another portion, and then the copper sulfate should be added to the lime suspension with vigorous stirring. Finally, enough water should be added to give the necessary volume. In making these small quantities it is best to use either the "snow" or the "powdered" grades of copper sulfate to speed up the process of dissolving it in water. Also, any hydrated lime that is used should be fresh; i.e., not carbonated by prolonged exposure to air. For small quantity needs, the table on page 61 will be helpful. The mixture should be used the same day it is prepared. It should be understood that this and other fungicides are preventive and not curative and should be sprayed on the plants before rather than after infection has occurred. Of course, further infection can frequently be checked by treatments made after the disease is observed.

The fixed coppers manufactured chiefly as oxides, oxychlorides and tribasic sulfates, are comparatively insoluble in water and thus can be applied to plant foliage without first adding the lime, which is necessary for use with copper sulfate in the preparation of bordeaux mixture. Since it has been found that the lime factor is chiefly responsible for the burning and stunting sometimes caused by bordeaux, the fixed coppers are as a group much less injurious to plants. The formulation of these fixed coppers for use on plants (in other words the recommended quantity to add to a given amount of water for the control of specific diseases) is complicated by the fact that the percentage of copper present in the different compounds (calculated as the metallic equivalent) varies all the way from about 20 to 85 per cent. Thus, for the sake of simplicity, all fixed copper formulas are calculated on the basis of a compound which contains 50 per cent of copper(such as Tribasic). Since the most commonly used concentration is 2 pounds of copper (in terms of copper as the metallic equivalent) in 100 gallons of water, those compounds that contain 50 per cent of copper are used at the rate of 4 pounds in 100 gallons. On this basis the amount of all other compounds is adjusted to furnish the same 2 pounds of copper, which would mean 8 pounds of a 25 per cent material and 2.5 pounds of one that contains 80 per cent of copper.

The fixed coppers are especially recommended to replace bordeaux mixture on tomatoes, cucumbers and muskmelons, but they should not be used on beans where they do cause more injury than does bordeaux. They are compatible with most of the commonly used insecticides and can thus be used in combination formulas. This group of copper compounds has also given good results when formulated as dusts with such diluents as the talcs, clays and other finely divided inert materials. A formulation that contains 7 per cent of copper as the metallic equivalent (14 per cent of a 50 per cent materials) is recommended for most crops. A 5 per cent mixture should be used on the cucurbits. When these 7 per cent dusts are used the application should be at at the rate of 40 to 60 pounds per acre and they should be applied in the early morning or late evening when air movement is at a minimum. The presence of dew also increases adhesion to the foliage.

Organic Fungicides

About the time the fixed coppers had become established as partial substitutes for bordeaux mixture a group of organic fungicides began to appear

in experimental programs on disease control. These now include a wide variety of compounds, but many of them are derivatives of dithiocarbamic acid. Trade names among the dithiocarbamates include such fungicides as Fermate and Karbam, which are used in the control of certain diseases of fruits and ornamentals; Zerlate and Methasan, which are particularly effective against tomato and other anthracnoses, and may also be used for early blight of potato and tomato; Dithane in the liquid and dry forms that give good control of early and late blight of potato and tomato; and a very similar product, known as Parzate, which controls the same diseases. Thiosan and Arasan are two others which are used for gray mold of lettuce and as a seed treatment, respectively. Within the next few years various other carbamates will undoubtedly be recommended for disease control. Phygon, Spergon, Bioquin and Puratized are other comparatively new organic compounds that are finding some use. The manufacturer's directions should be followed with all of these materials.

All-Purpose or "Shot-Gun" Mixtures
(Prepared commercially)

These are multiple purpose mixtures that usually contain two or more compounds, at least one insecticide and one fungicide, but more commonly two or more of each. For instance, rotenone and DDT might be combined with a fixed copper or with Zerlate and Parzate to give control of a wide variety of insects and diseases of garden crops. These are usually combined in a dust formula along with a carrier or diluent such as talc. These mixtures possess the advantage of making it unnecessary for the user to decide just what disease or insect he may wish to control on a specific crop and then purchase that only in the proper form. Instead, he buys the combination formula and uses it for whatever pest may be present. However, in using such an over-all control, he pays a premium in the form of wasted material for which he has paid a good price and gets no, or little, return. This tends to discourage the use of the all-purpose mixtures except in restricted quantities or on small areas.

●

Other Materials Having Special Use in the Garden

Commercial Bordeaux Mixtures

There are on the market a number of prepared or proprietary compounds that make bordeaux mixture when mixed with water. These materials are easy to use, but as a whole, give slightly less control of fungous diseases than home-made bordeaux and are a little more expensive.

Insecticides are included in some of these compounds and the manufacturers, therefore, recommend them for both insects and diseases. Where only small quantities of materials are to be used and the grower is not equipped to mix his own bordeaux, the use of a commercial product is advised.

Lead and Calcium Arsenate

Lead and calcium arsenate, while excellent materials for use against certain chewing insects, have been generally replaced by rotenone and DDT in the vegetable garden. This is because arsenical sprays, or dusts are: (1) much less toxic than rotenone or DDT, (2) the presence of both lead and arsenic residue is more objectionable on edible parts of plants, (3) arsenicals may injure bean foliage when applied for bean beetle control, and (4) leafhoppers as well as

beetles are controlled on potatoes by DDT, while arsenicals control only the beetles. For these reasons the use of lead or calcium arsenate in the *garden* has been almost discontinued. Lead arsenate is still used for certain leaf eating insects on trees and ornamentals.

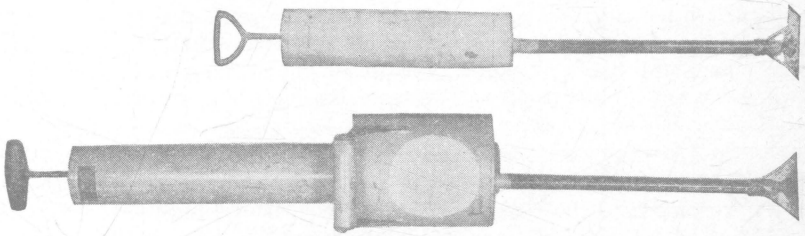


Fig. 68.—Hand dusters suitable for home gardens.

Pyrethrum Sprays and Dusts

There have commonly been offered for sale commercial sprays and dusts bearing pyrethrum extracts as a killing agent. This material, like nicotine, is very toxic to insects when it strikes them, and kills by paralyzing the insect. Pyrethrum products for use on vegetables are sold under various trade names.

Insects must be hit by the liquid, and there is no lasting protection secured by covering the foliage with spray or dust as in the case with rotenone, DDT, or with arsenicals.

Pyrethrum sprays or dusts are especially adapted to use on small plantings where expense is no item and on flowers where staining of the foliage or bloom would be objectionable. The recommendations of the manufacturer should be followed. For the control of plant bugs and for outdoor vegetable insects DDT has replaced pyrethrum.

Fig. 69.—Power duster suitable for large commercial areas.
(Courtesy Tobacco By-Products & Chem. Corp.)

Corrosive Sublimate

(For use in controlling cabbage, radish, and onion maggots)

The powder form of corrosive sublimate should be purchased and diluted with water at the rate of 1 ounce in 8 to 10 gallons of water. Moisten the soil about the young plants, ½ cup to each plant (see p. 11) in order to kill the eggs and newly hatched maggots. Use only in wooden or earthen vessel, as it corrodes metals. *This is poisonous. Keep away from children and livestock.*

Fluorine Compounds

These materials contain fluorine as the killing agent and are especially recommended for tomato hornworms, tomato fruitworm and blister beetles, all of which are difficult to kill with arsenicals. They are also effective against flea beetles and Mexican bean beetles. Fluorine compounds are sold under the trade names of Alcoro Cryolite and Kryocide (sodium aluminum fluoride). Cryolite can be purchased mixed with an equal part of diluent ready to be dusted on the plants. As a spray, apply at the rate of 3 pounds of cryolite to 50 gallons of water. In liquid applications the addition of a sticker is desirable.

Fluorines should *not* be combined with lime, bordeaux or with fixed copper.

Chlordane

This is a new organic compound superior to all other insecticides for *grasshopper* control and is now used widely for that purpose. It is available either as a 40 per cent wettable powder, or as a 5 per cent dust. The wettable form can be sprayed, or the dust form dusted around garden or flower borders as a barrier zone to protect the plants from grasshoppers; or when necessary applied lightly on the plants. For grasshoppers use 1 level tablespoon of the 40 per cent wettable powder in one gallon of water as a spray, or the 5 per cent dust as a dust. The latter form is also effective against ants. In the garden it is recommended principally for grasshoppers, root maggots and ants.

Chlordane does not promise to become a general garden insecticide, although in addition to the above mentioned insects it has been used successfully against rose chafers, cabbage and radish maggots, leaf-miners and against wireworms and white grubs when applied in the soil at the rate of 10 lbs. of actual chlordane per acre. Chlordane injures cucumber, squash and melon plants.

Benzene Hexachloride

Benzene hexachloride is a new organic compound sold under such trade names as Gamtox, Lexon 50, Gamex, Sixide and Gammaloid. The Toxicity of this compound is associated with the gamma isomer it carries and recommendations as to dilution depend upon the amount of the isomer present. This insecticide controls grasshoppers, spittle bug nymphs, aphids and some other pests that DDT will not control, as well as wireworms when it is applied to the soil and cultivated in. Unfortunately, it has a disagreeable odor which imparts an objectionable flavor to potatoes and other root crops when it is used for wireworm control. There is danger of imparting this flavor to vegetables, if used closer than three, or four weeks of maturity. The "off flavor" usually is not discernible until the product is cooked. Canning companies will *not* accept BHC treated vegetables.

Benzene hexachloride will *not* kill as wide a range of injurious insects as will DDT. It is ineffective against leafhoppers and loses its toxicity sooner than DDT when applied to plants. It also kills many beneficial insects including bees. It will be recommended only for specific purposes and until the pungent odor and tainting is removed, this insecticide will have very limited use in

the vegetable garden. If used, the high gamma BHC with most of the impurities removed, should be selected.

New Insecticides Recommended Only for Limited Specific Use

Benzene hexachloride. (see pages 13 and 42). This has too musty an odor for use except where insecticides fail as for spittle bug nymphs. Do *not* apply in soil as it imparts a bad taste to root crops.

Chlordane. (see pages 4, 11, 26 and 59). Recommended for grasshoppers, root maggots and for ants. Has been used successfuly against wireworms and grubs in tobacco beds, or hot-bed soils.

Methoxychlor (Marlate). This is an analog of DDT and can be applied to cucumbers, melons and squash for striped beetle control without stunting plants. Also effective against Mexican bean beetles.

Toxaphene. Excellent for control of bagworms and grasshoppers.

Azobenzene. Used only for red spider in greenhouses. Must be used very carefully to prevent plant injury.

HETP and TEPP. These give excellent control of plant lice and red spider, but lose their strength rapidly when mixed with water and applied. The manufacturers' directions should be followed. TEPP is very toxic in the concentrated form and must be used with extreme care. These phosphorus materials must be directed against the pests named. Recommended for use in greenhouses, where they are used as aerosols. They sometimes injure tomatoes.

Parathion. This is the outstanding performer among the new insecticides and has the widest effectiveness of all. It is an organic compound carrying phosphorus and is also very toxic to warm blooded animals. It controls more insects than DDT, but the spray or dust is not recommended generally on vegetables because of possible danger connected with its use. Parathion is now being used successfully as an aerosol to control most greenhouse insects and as a spray on flowers. It will be on the market in 1949 for specific uses mainly outside the field of vegetables.

Poisoned Bran Mash

(For use against cutworms, army worms, grasshoppers)

Ingredients	Small quantity	To cover ½ acre
Bran	1 quart	5 pounds
Paris green or white arsenic	1 level tablespoon	¼ pound
Sirup	2 tablespoons	1 pint
Water	1 pint	3 quarts

Mix the bran and Paris green dry. Stir the sirup into the water. Pour the sweetened liquid over the poisoned bran and mix thoroughly. Scatter mixture thinly where insects are feeding. Apply in early morning for grasshoppers; these insects die slowly after feeding. Apply in late afternoon or evening for cutworms and army worms; just as effective for cutworms if placed in small piles under pieces of board. Repeat in 3 days if necessary, paying particular attention to the area beyond the borders of the garden and across which the hoppers migrate to reach the vegetables or flowers.

Chlordane spray or dust is preferred to bran mash for grasshopper control (see page 59).

Keep Poisoned Bran Mash Away from Chickens

Fumigating Beans and Peas for Weevils

Weevils in beans, peas, and dried cereals can be killed by: (a) fumigating with carbon bisulfide or by (b) subjecting to dry heat for a period of time.

Carbon Bisulfide.—Place the seeds to be fumigated in a container that can be closed tightly. Use 1½ ounces, liquid measure, of carbon bisulfide (3 level tablespoons) to each 10 cubic feet of space in container. Place the carbon bisulfide in a saucer on top of seeds. Keep vessel closed 24 to 36 hours at a temperature of 65° to 80° F. Fumes will settle through air spaces and kill weevils without injuring the seeds for food or planting. *Keep fire or lights away.*

Heat.—Spread infested seeds in pans and subject to dry heat in oven, keeping the temperature, if possible, between 130 and 140° F. for 30 minutes. This temperature kills the eggs and larvae as well as the full-grown weevils, and does not injure germination if seeds are thoroughly dry.

Weevils can be presented from infesting dry beans by storing them in a closed container with ¼ their volume of hydrated lime to partially fill the interspaces.

Equivalent Dilution Strengths of Insecticidal and Fungicidal Sprays of Varying Concentrations

Columns 1 and 2 carry somewhat stronger strengths of insecticide than column 3. This is to compensate for probable inefficient sprayers used in home gardens

	No. of level tablespoons in one gal. of water	One level pint in this many gals. of water	This many pounds of material in 50 gals. of water
DDT (50%)*	1 1½	28 19	¾ 1
Ground Derris or Cube (4-5% Rotenone)	4	8	2½
Lead arsenate or Calcium arsenate	3 3½ 4	10 9 8	1¾ 2 2½
Nicotine sulfate and soap	2 1 cu. in.	60 4 lbs.	¾ pt 3
Pulverized copper sulfate	1⅓ 2 2⅔	25½ 17 12¾	2 3 4
Hydrated lime	3 4½ 6 7½	10 7½ 5⅛ 4½	2 3 4 5
Fermate	2½	14	1
Zerlate	2	16	1
Parzate	4	8	1
Dithane Z-78	2	17	1

*For 25% DDT use twice as much as here indicated.

Vegetable Seed Treatment

Crop	Materials and Methods of Treatment	Diseases Controlled
BROCCOLI CABBAGE CAULIFLOWER KALE KOHLRABI RUTABAGO TURNIP	Soak seed in hot water at 122° F (50° C) for 25 minutes for cabbage; all other seed 15 minutes. (Since this is a complicated treatment, purchase treated seed.) *plus* Dust with Semesan — ½ teaspoon per pound of seed.	Blackleg Black-rot Alternaria leaf spot Damping-off Wire-stem
CUCUMBER MELON PUMPKIN SQUASH	Corrosive sublimate (1-1000). 1 tablet for each pint of water, or 1 oz. for each 8 gals. water. Soak for 5 min. Rinse 15 min., then dry. (Use 1 gal. of solution for each lb. of seed.) *plus* Then dust with Semesan, *or* — ½ teaspoon per pound of seed. Arasan — 1 teaspoon per pound of seed.	Scab Angular leaf spot Anthracnose Seed decay Damping-off
BEET	Dust with Arasan, *or* — 2 level teaspoons per pound of seed. Semesan — ½ level teaspoon per pound of seed.	Seed decay Damping-off
EGGPLANT	Soak seed in hot water at 122° F (50° C) for 30 minutes and dry. *plus* Dust with Semesan *or* Arasan — ½ teaspoon per pound of seed.	Verticillium wilt Phomopsis blight Seed decay Damping-off
PEPPER	Soak seed 5 minutes in mercuric chloride 1 tablet in 3 pints of water. Rinse 15 minutes and dry. *plus* Dust with Semesan, *or* — ½ teaspoon per pound of seed. Arasan — 1 level teaspoon per pound of seed.	Bacterial spot Anthracnose Seed decay Damping-off
CARROT	Dust with Spergon, *or* —1 level teaspoon per pound of seed. Arasan	Seed decay Damping off
CELERY	Buy hot water treated seed, *or* soak seed in water at 118° F (48° C) for 30 minutes and dry. (Seed 2 or more years old does not need this treatment.) *plus* Dust with Zinc oxide — At manufacturers' recommendations.	Early blight Leaf spot Damping-off
ONION	(For *seed* onions) Formaldehyde 1 level pint in 15 gals. water and 125 gals. per acre in furrow with seed. If soil is dry use 1 pint in 16 gals. and 200 gals. per acre. *or* Dust with Arasan, or Thiosan — ¾ lb. of dust for each pound of seed and using ¼ pint of a 5% solution of Methocel as a sticker. Wet the seed with sticker first, then add dust and shake violently in closed container for several minutes. (For *set* onions) Dust with Arasan, or Fermate — 1 lb. with each 12½ lbs. of seed	Smut Damping-off Smut Damping-off
BEANS PEAS	Dust with Arasan, or Spergon — 2 oz. per bushel, or ½ level teaspoon per pound of seed.	Smut Damping-off
RADISH	Dust with Semesan, *or* — ½ teaspoon per pound of seed. Zinc oxide — 1 level teaspoon per pound of seed.	Seed decay Damping-off
SPINACH	Dust with Arasan, or Red copper oxide, *or* — 1 level teaspoon per pound of seed. Zinc oxide — 3 level teaspoons per pound of seed.	Seed decay Damping-off
SWEET CORN	Dust with Arasan, *or* — 1 oz. per bushel of seed. Semesan Jr., *or Spergon* — 1½ oz. per bushel of seed.	Seed decay Damping-off
TOMATOES	Soak seed in hot water at 122°F for 25 minutes. Dry. (This is a complicated treatment. If available purchase hot water treated seed.) *plus* Dust with Arasan — 1 level teaspoon per pound of seed.	Bacterial canker Bacterial spot Early blight Late blight Seed decay Damping off

NOTE: In using corrosive sublimate use only glass, wooden, or earthenware containers. Some seed treating compounds and spray materials are

POISONOUS. Keep them out of reach of children and livestock.

Never use copper compounds on crucifers (given in first group above).

Control of Damping-Off, Seed Decay, and Seed-Borne Diseases

Vegetable and flower growers have known of damping-off for at least a hundred years, but it is doubtful if many appreciate fully the extent of the injury. The embryo may be killed before the hypocotyl emerges from the seed-coat or somewhat later before the seedling emerges from the soil, or injury may be delayed until the plant is almost large enough to set in the field. The former injury we may designate as "pre-emergence" damping-off, which growers frequently attribute to poor seed, and the injury which takes place after the seedling has emerged from the soil as "post-emergence" damping-off. This injury to seedlings, in various stages of development, is known to be caused by one or more of several soil inhabiting fungi.

Seed treating chemical compounds are available which will control "pre-emergence" damping-off and also many of the seed-borne diseases. Usually one compound does not work equally well on all vegetable and flower seeds, and therefore several compounds should be available. (See page 62.)

Use of Formaldehyde for Control of Damping-off

Some growers may prefer to use formaldehyde for soil treatment where plants are grown in flats, or seedbeds. Either formaldehyde dust, or the Cornell modified liquid formaldehyde treatment may be used.

Formaldehyde Dust.—The formaldehyde dust is used in greenhouse flats where the soil is 2½ to 3 inches deep, at the rate of 1½ ounces of a 6 per cent formaldehyde dust per square foot of soil surface, or at the rate of ½ pound per bushel of soil. For detailed information about preparing and using formaldehyde dust, see Bulletin 520 of the Ohio Agricultural Experiment Station, Wooster, Ohio.

Cornell Modified Liquid Formaldehyde Treatment.—Use 2½ tablespoons of commercial formaldehyde per bushel of soil, or 1 tablespoon per 20 x 14 x 2¾ inch flat of soil.

Dilute formaldehyde with 5 or 6 parts of water, sprinkle over soil, and mix thoroughly. Place treated soil in flats or bench and allow it to stand for 12 to 24 hours *before* sowing seed. *After* seeds are sown water soil *thoroughly.*

The chief advantages of the formaldehyde treatments are that they are inexpensive and that they disinfect soil, seed, and flats in one operation.

Uses of Formaldehyde.—Excellent control of damping-off has been obtained by formaldehyde soil treatment on spinach, tomato, cucumber, beet, and most flower seeds. Other common vegetable and some flower seeds are either not benefitted or slightly injured.

Soil Fumigants

The use of soil fumigants has been found to be beneficial in some instances for the elimination of various insects (such as wireworms), soil-borne diseases (such as the wilts caused by various Fusaria), and both the meadow and root-knot nematodes. Any or all of these pests may occur in seedbed soils or in restricted outdoor soil areas that are protected from severe freezing during the winter months. Some of the most commonly-mentioned fumigants are,—chloropicrin (tear gas), ethylene dibromide, methyl bromide, and DD (a mixture of *dichloro-propane and dichloro-propene.*) Chloropicrin and methyl bromide will eliminate practically all soil-inhabiting pests including weed seeds. Ethylene dibromide and DD are most effective against nematodes. All do their best work at soil temperature of 50 or 60° F., or above. Some require water or paper seals over the soil to prevent too rapid escape of the fumigant. Each material should be used at its recommended rate (which varies for the different compounds). They should be placed in the soil at a depth of 4 to 6 inches on 6, 8, 10 or 12-inch centers, or in rows (furrows) these distances apart. Small areas

may be treated with hand applicators and larger ones by tractor driven equipmen. Soil for flats or seedbeds may be treated in drums or specially covered (sealed) piles. Some (chloropicrin and methyl bromide) are dangerous to use in the hands of a careless operator, and all may reduce germination of many crops if the fumigant has not escaped sufficiently from the soil. All this means that any of the materials mentioned should be used only according to the manufacturer's recommendations.

Wireworms and white grubs can be killed in the soil with benzene hexachloride, but its use as a soil fumigant is *not* recommended because the root crops grown in such soil are rendered inedible through the flavoring, or tainting of the product following its use. Chlordane offers more possibilities against wireworms and white grubs, but needs further testing before it can be recommended, except in plant-beds and cold-frames.

Hot Water Seed Treatment

For some fungi, which are carried within the seed coat and cannot be reached with formaldehyde or corrosive sublimate without injuring the seed, hot water has been recommended.

To treat seed with hot water proceed as follows: Heat several gallons of water to 122° F. (or to the recommended temperature) and remove from the fire. Have the seed tied loosely in cheesecloth bags with not more than ½ pound per bag. Immerse bags in the water, stirring with the thermometer or with a small ladle. Only thermometers approved by the U. S. Bureau of Standards should be used. Have additional boiling water handy, adding enough to keep the temperature constant. After treating seed for the required length of time remove from the hot water, rinse in clean cold water, and spread the seed out to dry. It should not be dried over a hot stove or in direct sunlight.

Hot water treatment of vegetable seed can best be done by a seed company. Purchase of such seed is advised rather than home treatment due to the possibility of injury. Cabbage seed produced in the Puget Sound area need not be hot water treated. In the case of tomato and bean, it is always best to buy certified seed, and in the case of tomato hot water treated seed is the best.

Post-Emergence Damping-Off

Post-emergence damping-off usually is not a serious problem in greenhouses or artificially heated cold frames. The disease causes the greatest losses in unheated cold frames, manure heated hotbeds, and during seasons when the spring is late and wet. Under these conditions, chemical soil treatments may be used, but they must be aided by good horticultural practices. The seed should be sown thinly in rows, they should be grown on the dry side, watered thoroughly only when necessary on mornings of bright days, and ventilated sufficiently to remove excess moisture.

An application of 4-2-100 bordeaux mixture,* applied with a sprinkling can at the rate of ½ gallon of the solution per 20 x 14 x 2¾ inch flat after all seedlings have emerged, is recommended for the control of post-emergence damping-off. This treatment should not be made on tomato plants within five days transplanting.

Most seedlings also are benefited by an application of red copper oxide (1 oz. to 3 gallons of water) as soon as the plants are up and at 5-to-7-day intervals. The material should reach the surface of the soil around the base of each plant. Always use the same spray on the same flats; do not alternate bordeaux and red copper oxide.

* For smaller amounts use 3 oz. copper sulfate, 1½ oz hydrated lime to 5 gallons of water.